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ABSTRACT

The papers presented at a symposium on geocoding describe the preparation of a geocoded data file, some basic applications for education planning, and its use in trend analysis to produce contour maps for any desired characteristic. Geocoding data involves locating each entity, such as students or schools, in terms of grid coordinates on a surface, and in conjunction with computer techniques has many applications and advantages. (RH)

THE APPLICATION OF GEOCODED DATA TO EDUCATIONAL PROBLEMS

A Symposium

1972 AERA

Chicago

by

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INTRODUCTION

The need for parsimoniously summarizing and tapping vast quantities of data is readily apparent to administrators in American Public Schools--particularly those in urban settings. A number of studies have revealed analyses of geocoded student data, trend surface analysis and linear programming techniques to be particularly useful in this regard. The efforts to be reported here have been carried on in two locations. The University of Wisconsin, Department of Educational Administration, in cooperation with the Milwaukee Public Schools has developed programs and applications related to a geocoded student file and trend surface analysis. Ralph Van Dusseldorp and his colleagues at the University of Iowa have been explaining the application of linear programming to geocoded data files.

Central to each of the techniques to be presented here is the notion of a geocoded file. In such a file, a record exists for each entity, possibly a school - or students in a school - and each record is coded with respect to X and Y location on the surface. In order to locate a given point on a surface, two numbers are required, the displacement to the right and above an arbitrarily assigned origin. Such a set of coordinates locates the relative position of points on a surface. Straight line distances between points may be computed or walking distances may be estimated when coordinates are identified. Precise knowledge of specific distances simplifies the analysis of transportation problems, the location of school boundaries, display of population densities, computation of trends across a surface, or frequency counts of specific attributes in a given geographic cell.

1. Some possible geocoded output products
(Mr. Costa)

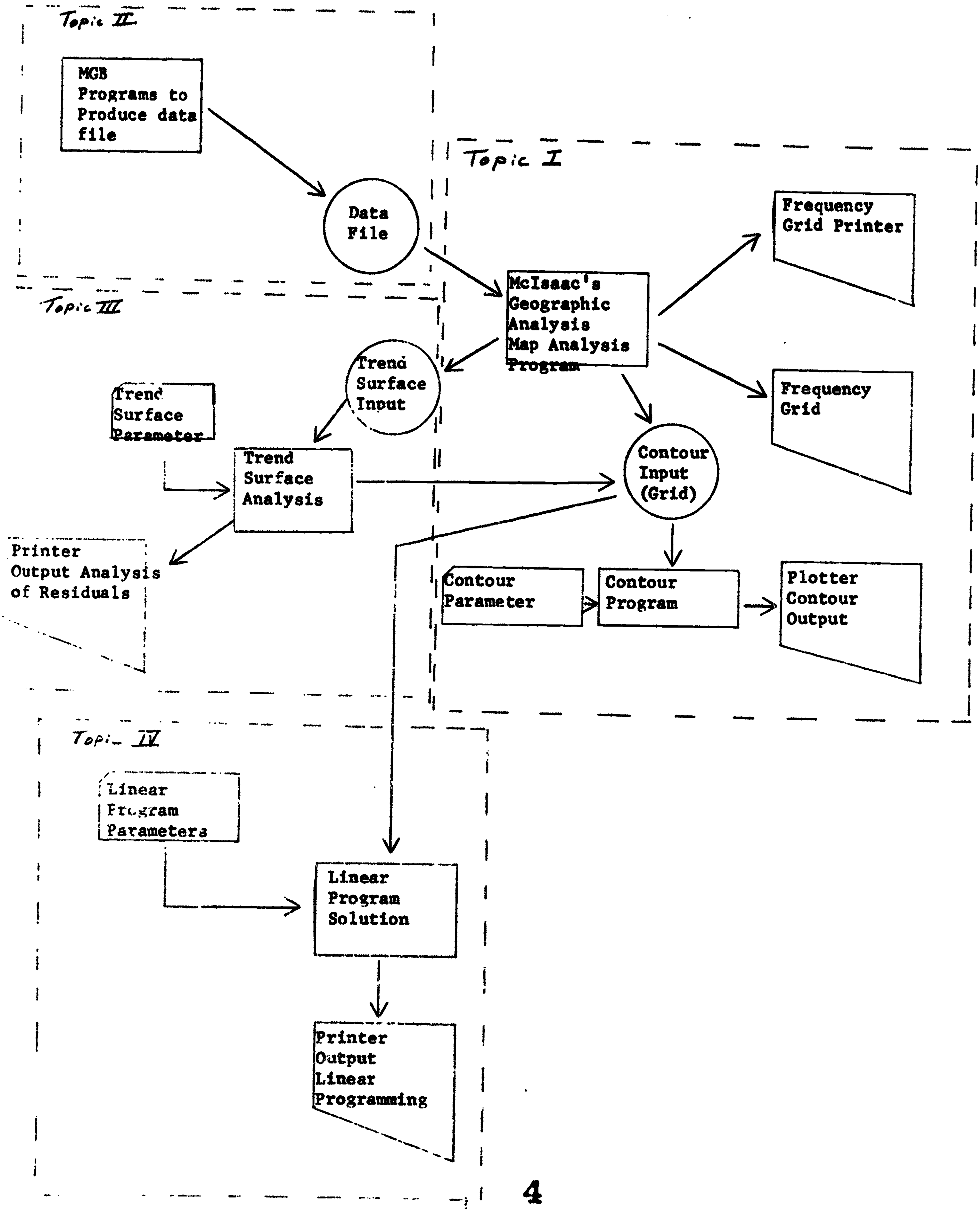
2. The preparation of a geocode file
(Mr. Spuck)

3. The application of trend surface analysis
(Mr. McIsaac)

4. The application of linear programming
(Mr. Van Dusseldorp)

Crist Costa will identify some of the output possibilities which have been useful to the Milwaukee Public Schools, including contour maps and location grids. Dennis Spuck will discuss the unique problems of creating a geocoded data file, with specific reference to large student data files. I will discuss the analytical and interpretation approaches associated with trend surface analysis. Ralph Van Dusseldorp will discuss the application of linear programming to a geocode file with specific reference to school boundary decisions.

John Peper of the Philadelphia Public Schools will respond to the presentations.



Topic II
MGB Programs to Produce data file
Data File
Topic I
McIsaac's Geographic Analysis Map Analysis Program
Frequency Grid Printer
Frequency Grid
Topic III
Trend Surface Input
Trend Surface Parameter
Trend Surface Analysis
Contour Input (Grid)
Printer Output Analysis of Residuals
Contour Parameter
Contour Program
Plotter Contour Output
Topic IV
Linear Program Parameters
Linear Program Solution
Printer Output Linear Programming

APPLICATIONS OF GEOCODING AND MAPPING

Paper Presented at Symposium on
The Application of Trend Surface Analysis and Geocoding to Problems of Education
1972 Annual Meeting, American Educational Research Association
Chicago, Illinois April 3-7, 1972

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Historical Development of Geographic Data Bases and Computer Mapping

The use of geocoding and mapping is not new to educators. If geocoding-geographic coding- is defined as some symbolic code denoting a geographic location, then street addresses, census tract numbers, block numbers, and city and street names, all represent geocodes. The census bureau has always been reporting its statistics by geocodes-geographic reference points. What is of recent vintage is the use of geocodes on computer readable files for the purpose of utilizing the computer's great speed to perform tasks other than to merely tally data on the basis of the geocodes. In addition to the preparation of tallies, it was noted that characteristics of geographic areas could be converted to a computer readable format such that the computer could literally produce maps of areas or concentrations of characteristics. It is these two rather recent uses of the computer that provides the basis for this paper.

In October of 1968, Edward Ide presented a paper to the Association for Computing Machinery's Annual Symposium on the Application of Computers to the Problems of Urban Society. His paper was entitled "Address Coding to Produce Age-Race Data by City Blocks for School Planning". This paper dealt with a problem similar to that of Milwaukee namely the preparation of detailed geographical tabulations of school population.

Early Developments By The Census Bureau

Perhaps the more well known work done on geocoding and computer mapping techniques has been accomplished via the Census Use Study performed by the Bureau of the Census. These two techniques were investigated as part of the Census Use Study which was a small-area data research study sponsored by the Bureau of the

Census and performed in New Haven, Connecticut from September 1966 to July 1969. This study was established to explore the current uses and future needs of small-area data and data handling and display techniques in local, state, and federal agencies. The results of this study can be found in eleven different reports and three different computer packages all available by contacting the Department of Commerce, Bureau of the Census. (See Appendix)

Statement of the Problem

In the Fall of 1969 and the Spring of 1970, the Milwaukee Public Schools (MPS) was undergoing a period of rearrangement. By rearrangement, I mean that a number of attendance areas within the district were undergoing a careful scrutiny for the purpose of reviewing whether or not their redistricting was necessary. When the actual work got under way, the method used to plot student density was the tried and true "pin map" method. The obvious shortcoming to this approach, is that with a large school district such as Milwaukee, 130,000 + students, one either needs, many pins and pinstickers, or small geographic areas for plotting density, or both. Without one of these givens, it becomes such a horrendous task, that a recount of the data is impossible and a loss of pins a nightmare. This major undertaking in the 1969-70 school year was the problem whose need for a solution led to a search for the proverbial "better mousetrap," for future redistricting projects. Since one major project was already anticipated for the Spring of 1971, the improved method was needed quickly.

In June of 1970, Dr. Donald McIsaac, his staff, and members of the Milwaukee Public Schools' Division of Planning and Long-Range Development met for the first time to discuss Dr. McIsaac's proposal for converting our student file to a geographic data base. The work commenced in June of 1970 and continued into the

fall with the first piece of useable output available in November of 1970. Additional output was prepared with the project being completed in February 1971 and redistricting recommendations being submitted a few weeks later.

This system developed by Dr. McIsaac and his staff has been used in three major areas of concern at Milwaukee since its development. Each area of emphasis will now be reviewed.

Actual Applications in Milwaukee

School Redistricting

As mentioned previously, the first project utilizing the computer mapping system was one involved in redistricting. The objective of the redistricting project was to identify boundaries to solve the immediate problem of school overcrowding and to identify possible future boundaries for new smaller districts sometime in the future. The area under investigation was approximately six miles by four miles and consisted of land recently annexed by the city of Milwaukee. This area was to be divided into a number of elementary school districts to accomodate the three existing elementary schools acquired through annexation as well as the two elementary and one senior high planned to be built over the next five years. This area was of additional concern because of two very large housing developments which were under construction in the Fall of 1970 and expected to be providing students to the schools by 1971.

As mentioned earlier, the standard procedure would have been to prepare hand tallies or pin maps of the student population in the area and then prepare recommendations upon completion of the analysis of the maps or tallies. The availability of the geo-coding system made the task somewhat easier.

The first step was to identify a student file which was satisfactory for geocoding. Two such files were available. One file was the MPS Student Data Bank - a centralized computer file containing a basic record on all pupils in the MPS. This file was not used since it was felt that data on pre-school students were also needed but was not available in this file.

The file chosen was that which is available from the annual Student Census. The Milwaukee Public Schools is charged by state statute with the responsibility of taking an annual census of all children living within the area to be served by Milwaukee Public Schools. The final census tallies are prepared by processing a mark sense card which is prepared for every child counted in the census. This card contains the child's age (0-18), sex, type of school attended (private or public, none), and the home address of the student. This card is then converted to a punched card format and put into a reel of magnetic tape for report generation and later storage. It was this student census file which was converted to a geocoded data base and then used to produce a location grid.

A number of such grids were produced including grids which grouped children by age into probable school attendane type - pre-school, elementary, junior high and senior high. These grids were prepared at a scale consistent with some maps specifically prepared for MPS. Since the location grids are prepared on transparent paper, it was possible to overlay the grids onto the maps, and begin analyzing the pupil density by age, type of school attendance, or geographic location by either changing and then comparing grids or by hand counting the various tallies.

The only drawback to this system, is that which occurs if the scale is too small. When the scale is small, the tallies are prepared on such a large real geographic area that when the tallies are displayed, the value may appear in a geographic area which has no homes at all. When this occurs, the analyst must call upon his knowledge of the area to determine the probable allocation of the students used in the development of the figure.

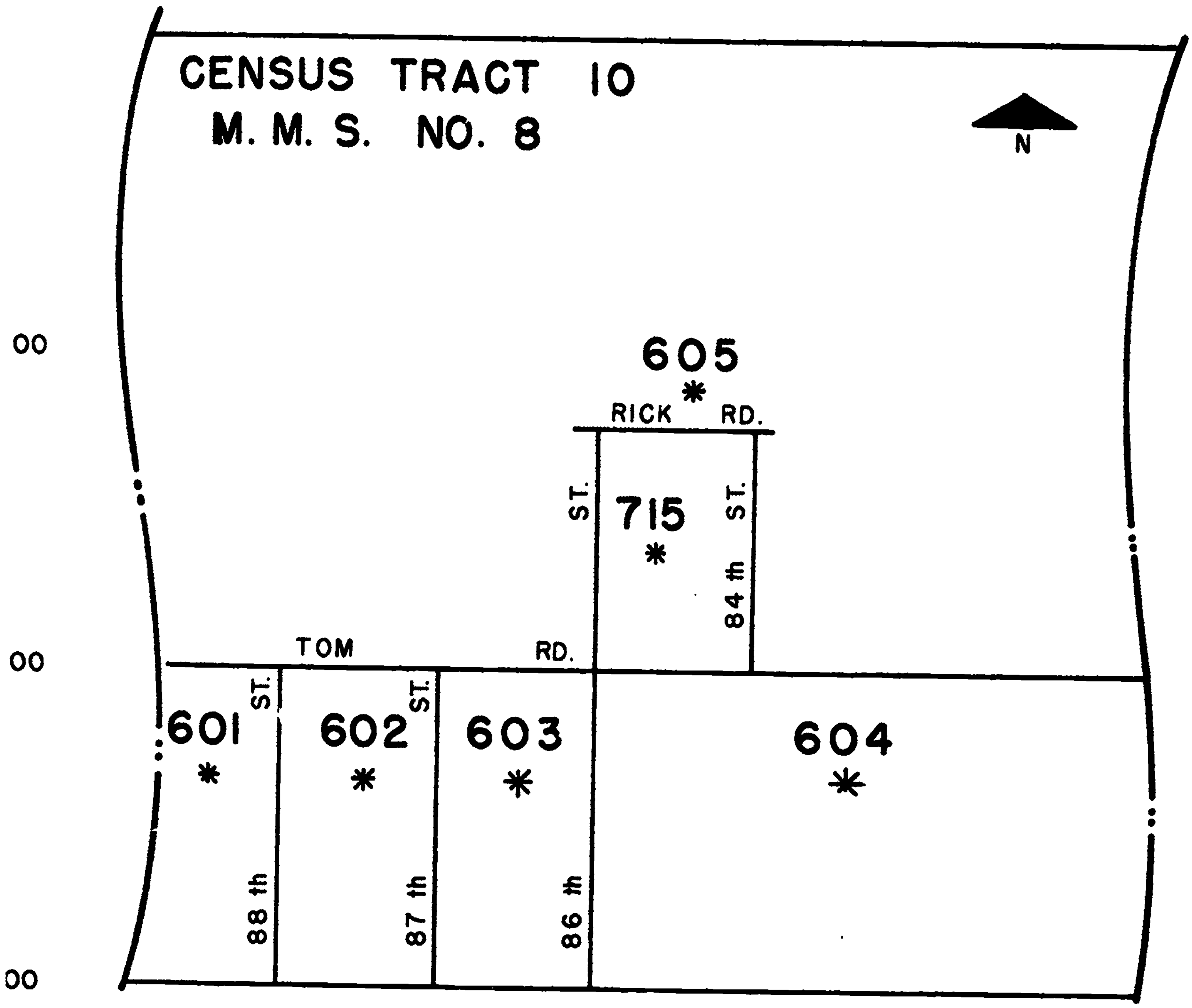
As an example see Figure 1. Suppose the area found south of Tom Road but east of 86th Street is a cemetery but there are houses on the north side of Tom Road and on all other streets pictured in the map. Should the scale be made too small, it is possible through coincidence for all of the students found in the area bounded by that map to appear to be referenced to block number 604. With the figure appearing in the cemetery, the untrained observer will assume that an error has been made and thus treat the results with suspicion. Aside from this minor, though correctable situation, the system performed quite well.

The advantages are:

a. Should one wish to analyze a specific area more closely, it is a simple matter once the data base has been constructed, to request new plots at a larger scale. This type of request would not be as simple using a pin map.

b. Because of the computer's speed, it was possible to scrutinize the student population in the districts surrounding the area of interest with little additional effort. Developing location grids for relatively large areas is very easy using the speed of the computer as opposed to the effort of preparing additional pin-maps.

While this would have been necessary under any circumstance, it was much easier to tally the 16,000 + students within the area as well as the 2 or 3 thousand additional students in the surrounding area via this method as opposed to using additional pin stickers.



CENSUS TRACT 10
M. M. S. NO. 8
N
00
00
00
605
RICK RD.
715
ST.
84 th ST.
TOM RD.
601
88 th ST.
602
87 th ST.
603
86 th
604

FIGURE 1

Identification of Title I Areas

".....The proposal must of necessity include the determination of what constitutes the eligible Title I area, and within those areas which schools reflect the greatest economic deprivation." If you are from a district using E.S.E.A. Title I money, you will probably recognize this statement, for you know that the schools should be reclassified each year. The solution to this problem was somewhat similar to a solution described earlier. As before, the appropriate file needed to be located, geocoded, and then tallies prepared for each geographic area.

The Title I guidelines recommend that local districts utilize Federal Census Data where possible. For 1971, the Fourth Count Summary Tape had not yet been released and so economic data was not available. Population and Housing characteristics which might relate to poverty were employed where possible, but it was still desireable to locate appropriate economic data. The data available were from the local A.F.D.C. Files. These data were utilized in previous years for the same purposes. In 1970, it took over six man weeks to tally the 15,000 A.F.D.C. records via the pin map approach. In actual man days, it took almost as long in 1971 with the new computer system, but now we were processing in excess of 24,000 records.

This being the first time that the geocoding system was tested on the entire city, additional time was needed to thoroughly review the system's performance. While the system's conceptual design indicated that it should work, in fact, some minor technical problems were encountered which required some minor reprogramming and modifications and yet the project was completed 1 man-month earlier than the previous activities.

After the A.F.D.C. data were geocoded, location grids were prepared at an appropriate scale permitting tallies to be made by school district. The only shortcoming to this method, was the previously mentioned problem of having a tally appear on the plot such that it appears to have children living in areas which have no housing. This problem was resolved by using a larger scale. In addition to the location grid, a contour map was drawn so as to develop a more graphic picture of the concentration of pupils being counted. Both the contour map and the location grids were used by members of the MPS Title I staff to explain the procedures used in Title I school identification to members of the Title I Parents Advisory Council. This year unlike years past, though there were criticisms of the final list, there was no real criticism of the method used to place schools on the list. While that sentence may seem to lack logic, what is meant is that they approved the decision-making process, it was the decision coming from the process which wasn't liked.

It is anticipated that this computer mapping will again be used in 1972 for the new reclassification of Title I Schools.

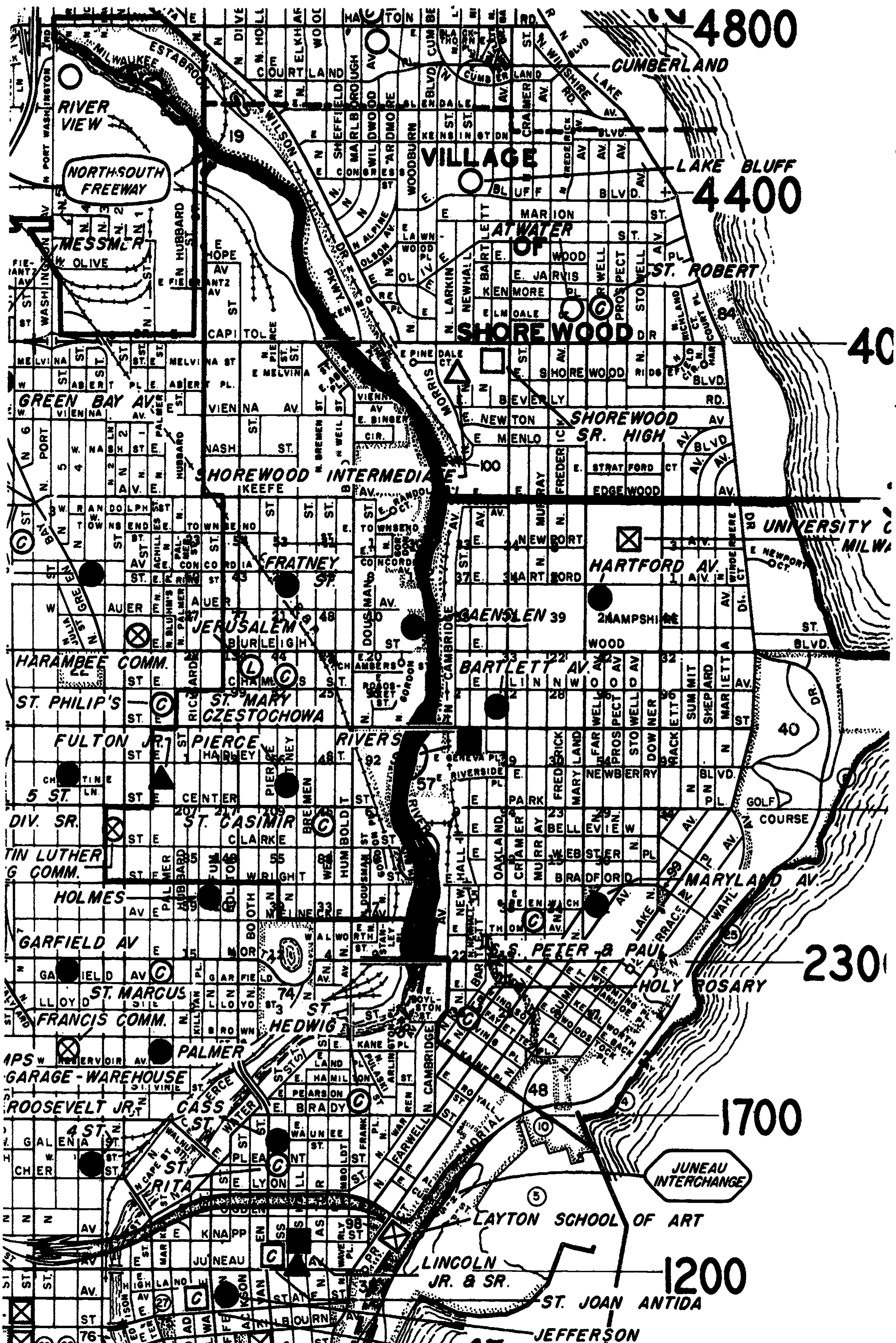
The Capital Improvements Program

The last and most current use of the computer mapping program has been to develop supporting data for school resource teams and members of the local school community in their development of recommendations supporting new school construction. One of the responsibilities of the Division of Planning and Long-Range Development is to provide demographic data to the resource teams. One of the most frequent requests by the resource team is for data concerning the school's future population. Though forecasts of the potential population are possible,

through the use of enrollment projections the mapping and geo-coding system being disucssed offers a more dynamic method of forecasting populations. The standard enrollment projection techniques assume fixed school boundaries. By using the location grids previously discussed, it is possible to analyze the possible effects on the future school population through redistricting. Because of this capability, in addition to the demographic data available through the 1970 census, the school resource teams also request location grids of the potential student population in the present school boundary as well as all contiguous districts. Invariably, the members of the team who haven't used these grids before are extremely pleased with there usefulness. This satisfaction is expressed even when it does nothing more than confirm their intuitive feelings about the area.

The following map and location grid will serve as an example of its use in this area. You will note that the river runs right through the district and yet from a cursory view of the values, you'll also note that most of the school population lives west of the river. Prior to the grid plot, members of the community expressed interest in expanding the school's northern and southern boundaries but making the river serve as the western boundary. A look at the data values indicates that the northern and southern boundaries would have to be extended a great distance to make up for the large number of students which could be served by simply extending the western boundary a few blocks.

As an additional note, the values which are circled, exemplify the phenomenon described earlier where data values appear in erroneous positions. Obviously no one lives in the river, but rather near enough to it so that when the value is printed, it appears in the river.



4800
CUMBERLAND
RIVER VIEW
NORTH-SOUTH FREEWAY
VILLAGE
LAKE BLUFF
4400
ATWATER
MESSMER
ST. ROBERT
SHOREWOOD
SHOREWOOD SR. HIGH
GREEN BAY AV.
SHOREWOOD INTERMEDIATE
UNIVERSITY
HARTFORD AV.
FRATNEY ST.
GAENSLEN
JERUSALEM
HARAMBEE COMM.
BARTLETT AV.
ST. PHILIP'S
ST. MARY CZESTOCHOWA
FULTON JR.
PIERCE
RIVERSIDE
5 ST.
DIV. SR.
ST. CASIMIR
GOLF COURSE
MARTIN LUTHER KING COMM.
HOLMES
MARYLAND AV.
GARFIELD AV
SS. PETER & PAUL
2300
HOLY ROSARY
ST. MARCUS
FRANCIS COMM.
ST. HEDWIG
PALMER
GARAGE-WAREHOUSE
ROOSEVELT JR.
CASS ST.
1700
4 ST.
ST. RITA
JUNEAU INTERCHANGE
LAYTON SCHOOL OF ART
LINCOLN JR. & SR.
1200
ST. JOAN ANTIDA
JEFFERSON

Relevant Literature on the Topic of Geocoding

1. Barb, Charles E., "Street Address Conversion System". A paper presented at the Urban and Regional Information Systems Association Conference, September 7, 1968, Clayton, Missouri.

2. Cooke, Donald F., "Dual Independent Map Encoding (D.I.M.E.)". Unknown

3. Cooke, Donald F., "Street Address Matching". Unknown

4. Horwood, Edgar M., "The Basis of Urban Geocodes". Unknown

5. Ide, Edward A., "Address Coding to Produce Age-Race Data by City Block For School Planning". Paper presented at the Association For Computing Machinery-Annual Symposium on the Application of Computers to the Problems of Urban Society, October 18, 1968.

6. Leyland, George, "The Ecological Problem in Small Area Data". Unknown

7. U. S. Department of Commerce-Bureau of the Census. Conference Proceedings November 1970, Wichita, Kansas on Use of Address Coding Guides in Geographic Coding—Case Studies. Washington: Government Printing Office, 1970.

8. U. S. Department of Commerce-Bureau of the Census. Conference Proceedings April 1-2, 1971, Jacksonville, Florida, on Geographic Base Files—Plans, Progress, and Prospects. Washington: Government Printing Office, 1970.

9. U. S. Department of Commerce-Bureau of the Census: Census Use Study Documentation. Washington: Government Printing Office.

    a. Reports
        1. General Description.
        2. Computer Mapping.
        3. Data Tabulation Activities.
        4. The DIME Geocoding System.
        5. Data Interests of Local Agencies.
        6. Family Health Survey.
        7. Health Information System.
        8. Data Uses in Health Planning.
        9. Data Uses in Urban Planning.
        10. Data Uses in School Administration
        11. Area Travel Survey.
        12. Health Information System-II.
        13. Computer Resource Allocation Model (CRAM).
        14. Geocoding with ADMATCH-A Los Angeles Experience.

b. Computer Program Packages.

1. ADMATCH: An Address Matching System. A computer program package designed for use in assigning geographic codes to local records using a DIME or similar geographic base file. Includes a users manual and computer programs.

2. DIME: A Geographic Base File System. A computer program package for creating a DIME geographic base file. Includes clerical instruction, a computer manual, and programs.

3. GRIDS: A Computer Mapping System. A computer program package for use on small-scale computers which provides three mapping options within a grid pattern: density, shading, and value maps. Includes users manual and computer programs.

TOPIC II

DATA BASE CONSIDERATIONS

Dennis W. Spuck

Introduction

As was demonstrated in the previous discussion, the geographic data base may be put to a variety of very practical uses in school districts. The purpose is to present information in a form in which it may be readily assimilated and used by educational decision-makers. This presentation is directed toward consideration of ways in which a geographic data base may be constructed, utilizing, to the extent possible, materials already existing in the district.

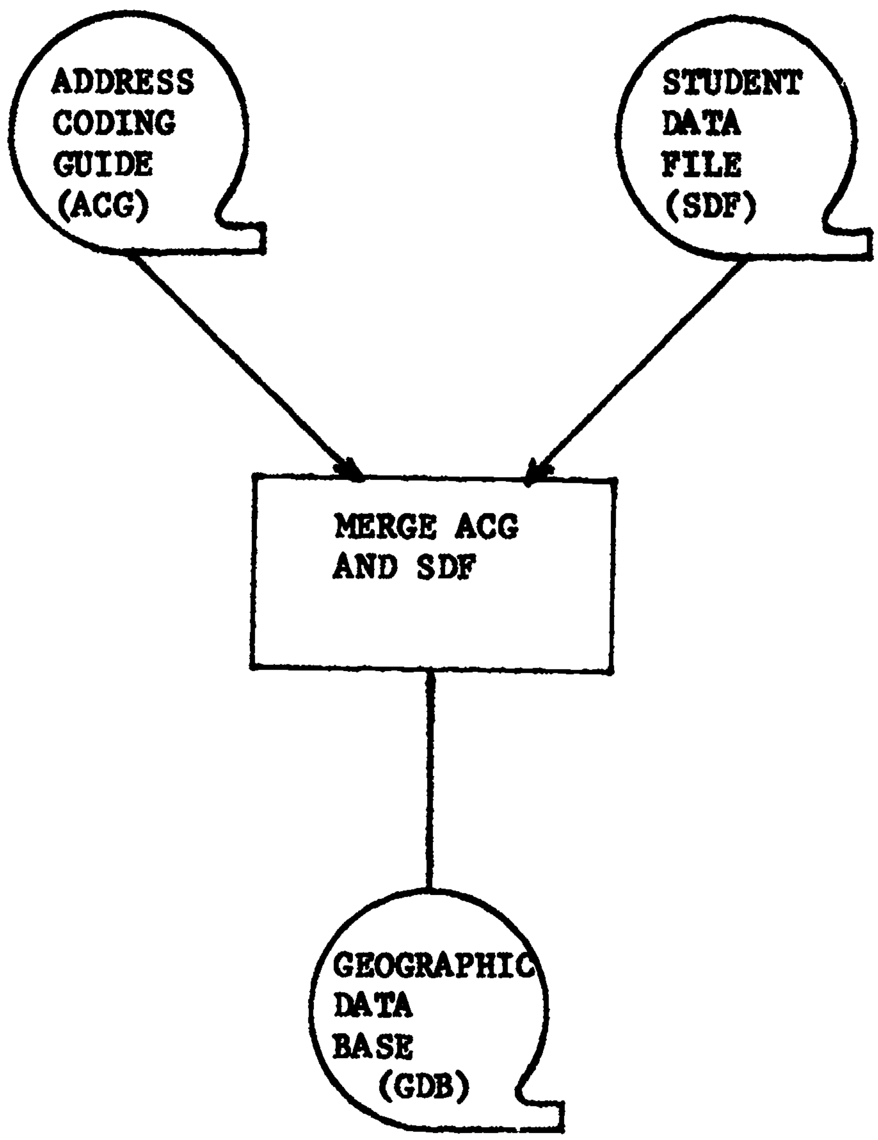
To form a geographic data base, information must be related to a point on a geographic surface. A map forms a two-dimensional surface; as such, any point on the map may be located by moving to a position a specified distance over from the lower left-hand corner of the map and then moving a specified distance up from that position. This is not unlike the frequently encountered street locator on a city map, which overlays the map surface

with a grid. The columns of the grid are labeled alphabetically and rows of the grid are labeled numerically. To find a street, one must search only within the grid associated with the alphabetic character and the numeral. As the grid sizes become smaller, the location of the street becomes fixed in a smaller and smaller geographic region. The limit of this operation would be a statement of the exact distance over and up from the lower left corner of the map. In this case, it is often easier to use a direct measure of distance, inches on the map, for example, than to use the alphabetic and numeric codes. A geographic data base is a collection of information about a set of individuals or objects which includes for each individual or object in the set its location on an appropriate geographic surface. If we assembled a set of information for each student in a school district, including the student's age, grade, and reading level, and added to this collection of information the location of the student's residence, then this set of information would form a geographic data base. The following discussion focuses on building and updating a geographic data base for students in a middle size or large school district.

While several approaches might be taken in the creation of a geographic data base, the procedures outlined here will capitalize on information already existing in or readily available to school districts of moderate size. Geographic data bases can be established for smaller cities, but as will become clear later, much useful information is already available for larger cities. Two separate collections of information, data files, will be combined to produce the geographic data base: 1) an address coding guide and 2) a student data file. This process is pictured in Figure 1.

The Address Coding Guide

The Address Coding Guide (ACG) contains information relating street



PRODUCING THE GEOGRAPHIC DATA BASE

FIGURE 1

names and address ranges to position on a geographic surface or map. It would be possible to locate each student residence individually on the geographic surface, but this degree of precision is generally unnecessary. For most applications, it is sufficient to locate the position of the center of the block and to assume that all residences located on that block are concentrated at its center. This process is outlined in the flow chart labeled Figure 2.

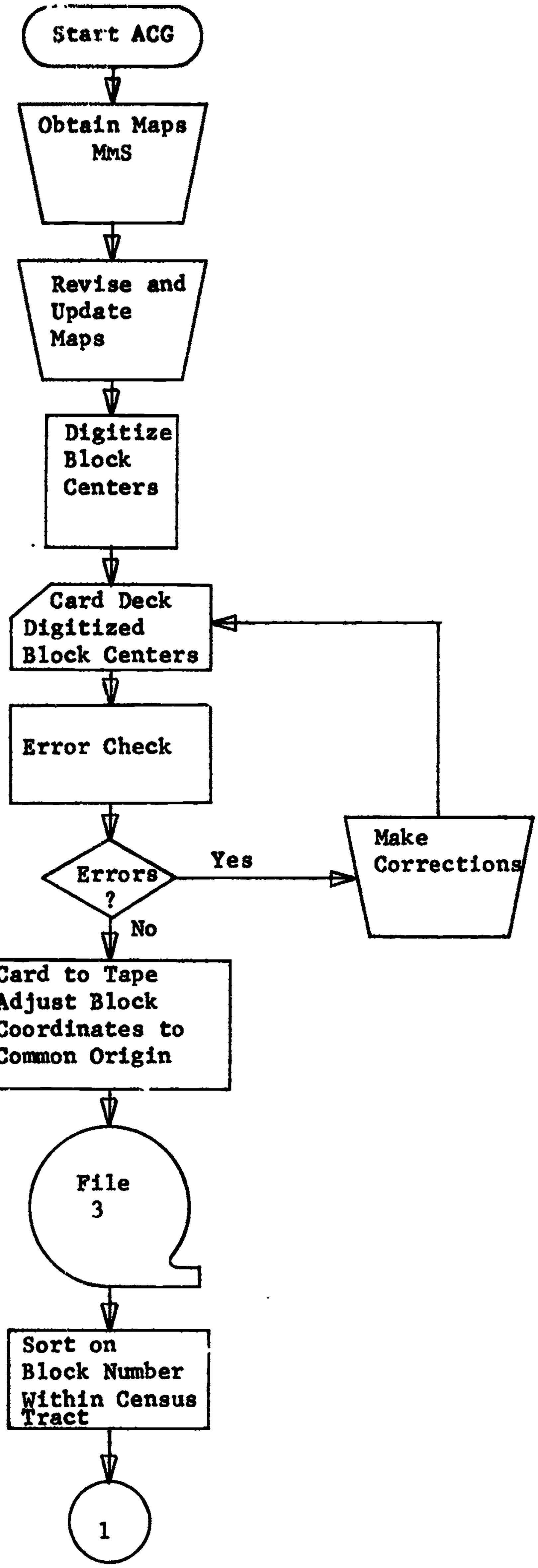
Creation of the ACG, begins with the selection of maps which depict the area of interest down to the block unit. The United States Bureau of the Census produces maps for all Standard Metropolitan Statistical Areas (SMSA), cities of 50,000 or more inhabitants. This collection of maps is called the Metropolitan Map Series (MMS) and is available from the Bureau of Census. Each map delineates the geographic region down to the city block unit. The maps are divided into census tracts and the census tracts are subdivided into blocks. Maps, census tracts and blocks are all labeled by number. Figure 3 is a portion of a map in the Metropolitan Map Series which shows census tracts, (large numerals) and block numbers (small numerals).

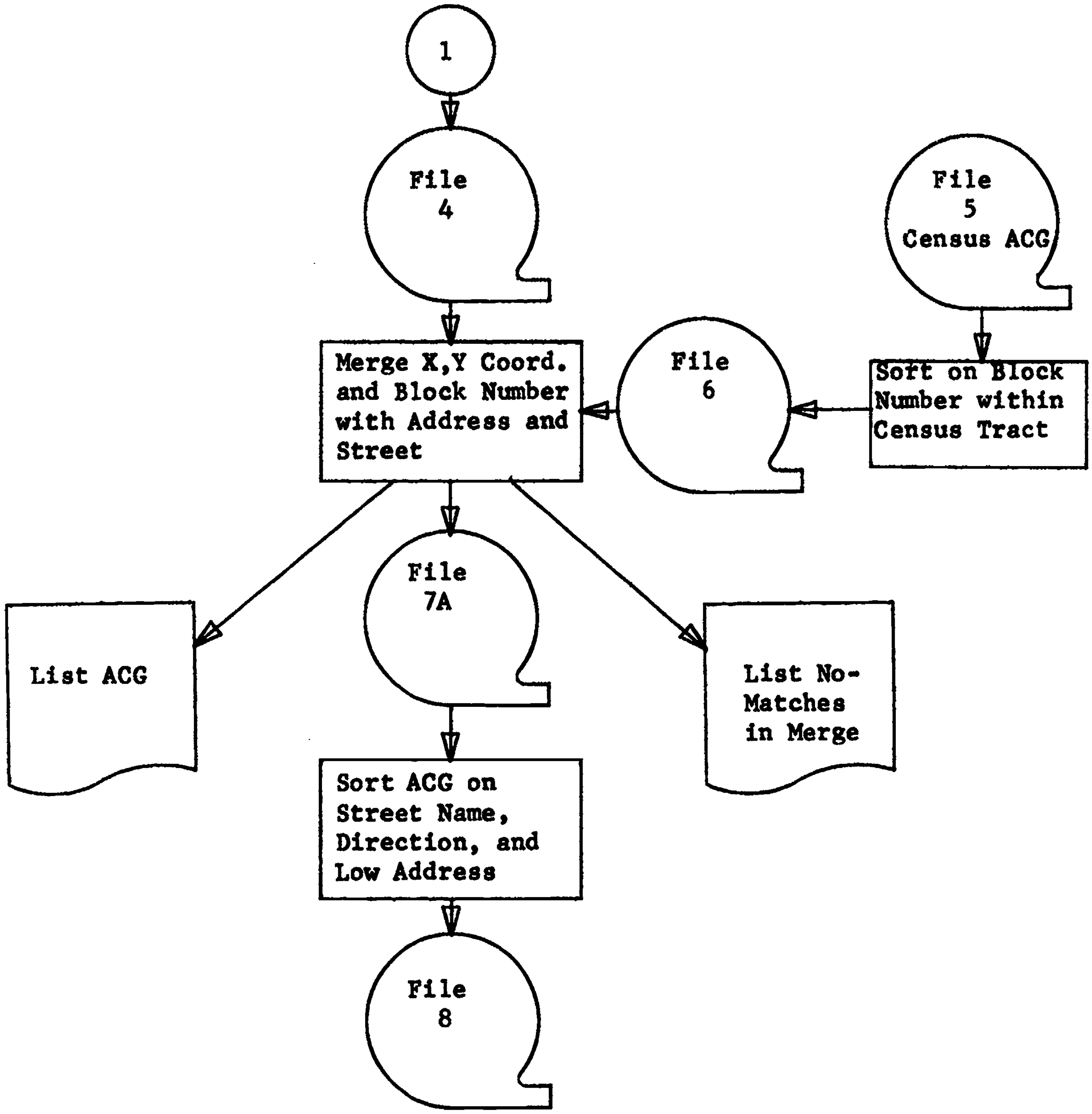
The next step in building a geocoded Address Coding Guide is to update the maps. These maps are generally a few years old and need to be corrected to include new and changed streets. This information may often be obtained from the local planning commission. All new blocks added need to be numbered within their respective census tracts.

Since the geographic unit to be coded is the block center, the exact location of each block center must be established. This location is usually measured from an aribtrary point of origin near the lower left-hand corner of the map. It is chosen since all distances measured over and up from it will be positive in direction, obviating the need for assigning some distances a negative length (direction). Figure 4 gives a close-up view of several

BUILDING THE ADDRESS CODING GUIDE

FIGURE 2





BUILDING THE ADDRESS CODING GUIDE
(Continued)

FIGURE 2

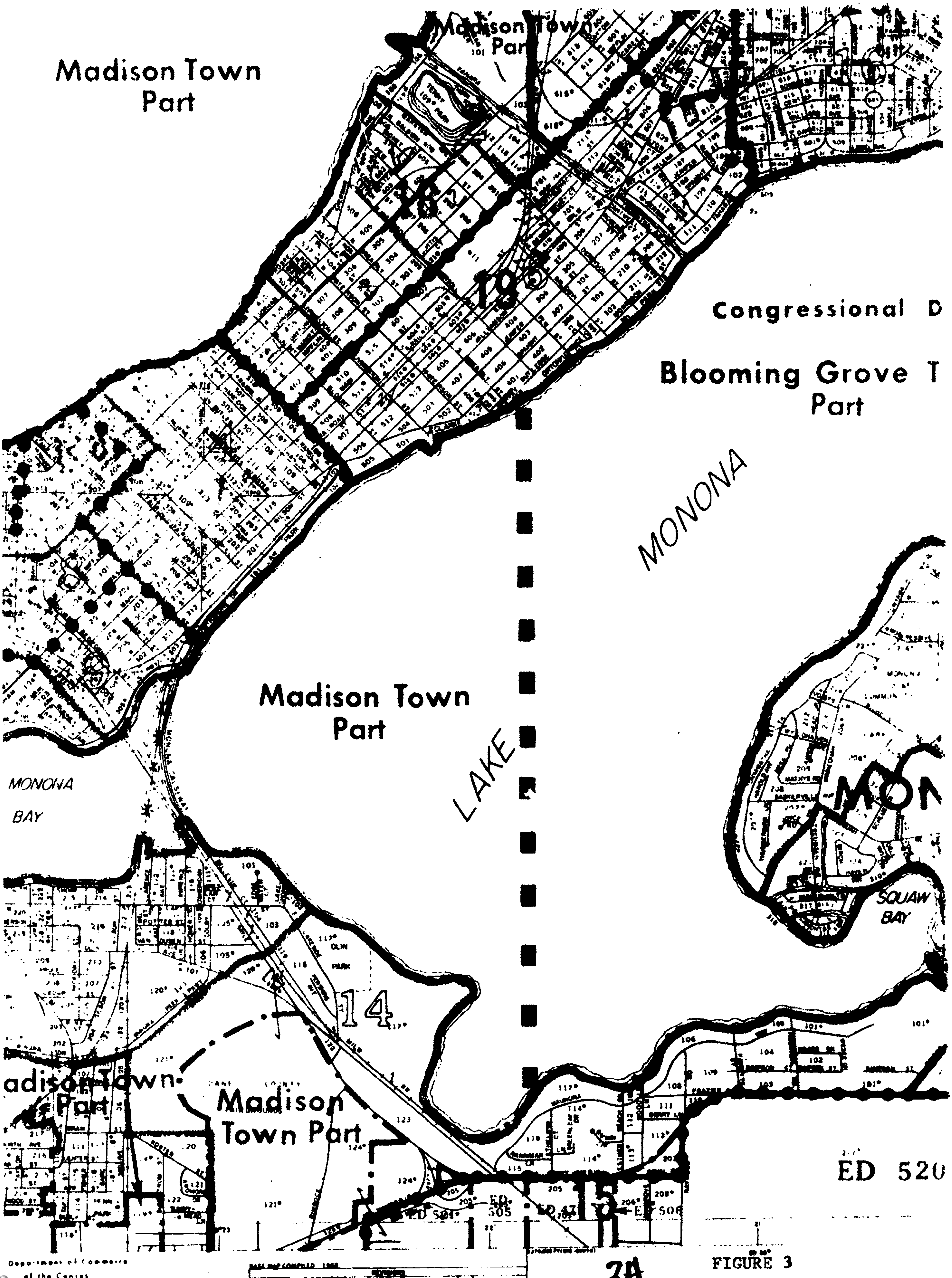

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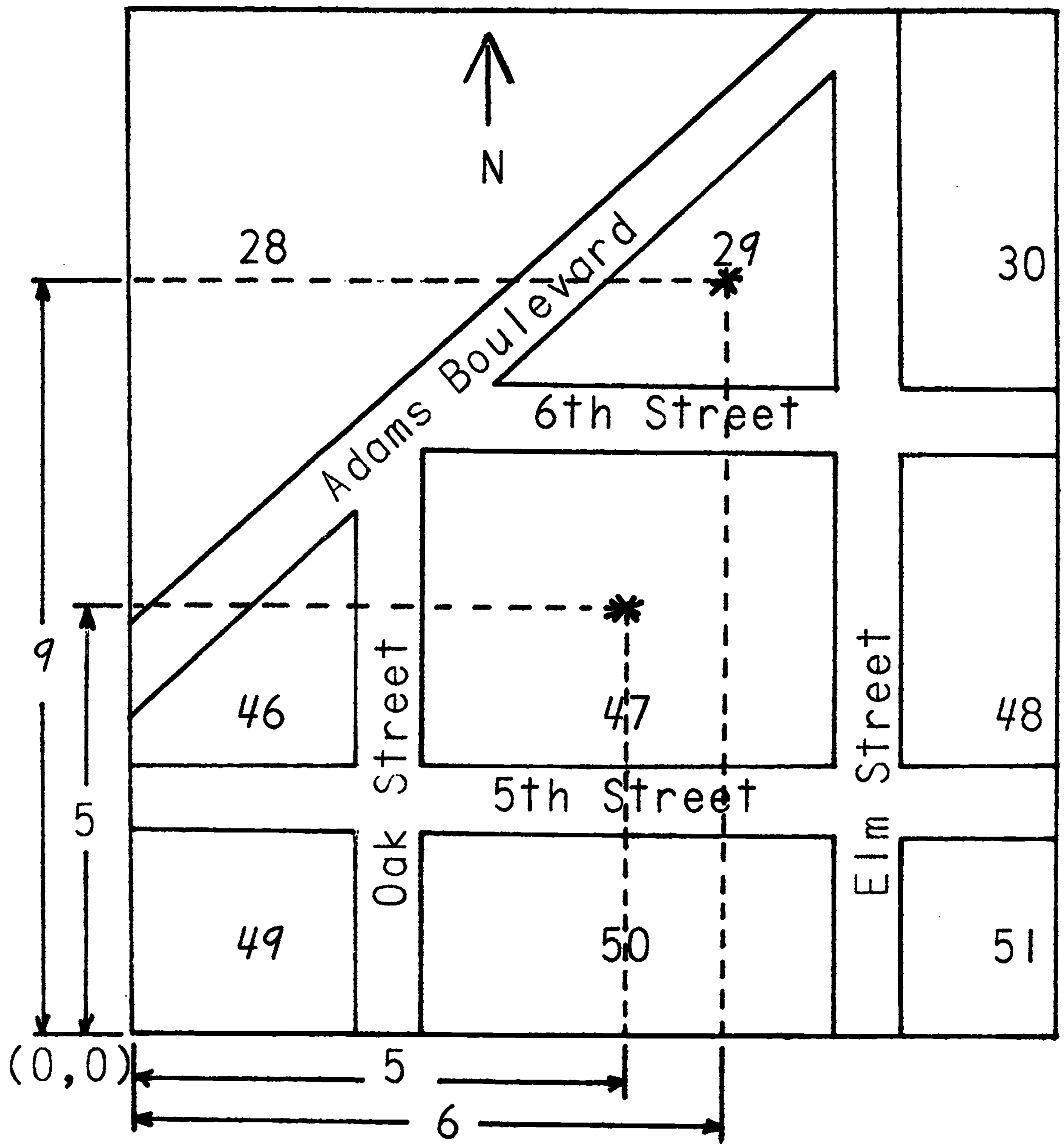
FIGURE 3



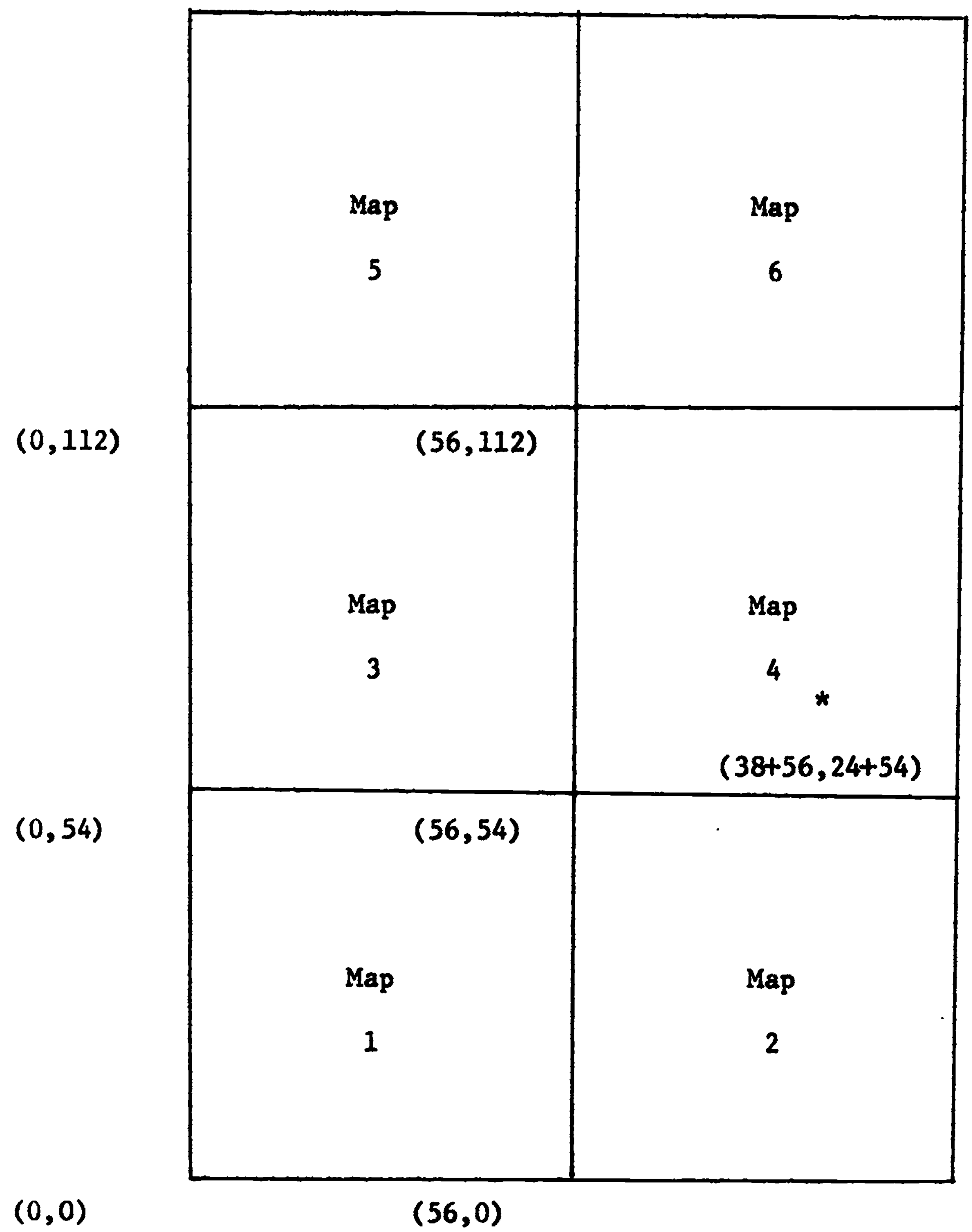
DIGITIZING BLOCK CENTERS

Figure 4

blocks; the origin is taken as the lower left-hand corner of the map and the location (coordinates) of the center of block number 47 is 5 units over (X coordinate) and 5 units up (Y coordinate). It should be noted at this time, too, that there are four block faces associated with this block center. All of the residences on one side of Oak Street, 6th Street, Elm Street and 5th Street are assumed to be located at the center of this block. Another block center, number 29, is also pictured; this block center has three block faces associated with it. Residents on opposite sides of a street are associated with different block faces and block centers.

Precisely fixing the location of block centers is a tedious task, the burden of which is somewhat eased by a machine called the digitizer. This machine facilitates the process by automatically coding the X and Y coordinates of a block center in a computer card. The map is placed on the surface of the digitizer table. The first step is to punch the map number and the location of the four map corners into a card; this information will later be used to put together all of the maps which cover the geographic area. For each block center on the map, the map number, the census tract and the block number are manually punched into the card, then the cursor of the digitizer is placed over the block center, automatically coding its coordinates. The digitizing process is repeated for each block center and each map in the series.

All of the block centers coded thusly have coordinates punched relative to the lower left corner of the map. It is necessary to convert these relative block center coordinates to a common origin. In order to accomplish this, the maps are placed in order, see Figure 5, and the origin of the map in the lower left is selected as the common origin. The coordinates of each block center coded are then adjusted by adding the coordinates of its map's origin, relative to the common origin, to the X and Y coordinates



ADJUSTING BLOCK COORDINATES TO COMMON ORIGIN

FIGURE 5

of the block center. Figure 5 shows a block center coded as having coordinates 38 and 24 relative to map four, but the origin of this map relative to the origin of map one- the common origin-is X equal 56 and Y equal 54, so that the adjusted coordinates are 94 and 78 respectively. Digitizing software includes computer programs which automatically rotate and transpose the origins of many maps to a common origin.

The United States Bureau of the Census in cooperation with local planning agencies, produces for each SMSA an address coding guide (ACG). Essentially, this guide is an inventory of streets and address ranges for each block face in the area. This inventory also contains information relating the block face to a block number within a given census tract on a specific map in the MMS. The information of interest contained in this ACG is:

1. Map number
2. Census tract
3. Block number
4. Street name
5. Street direction
6. Block low address
7. Block high address

The address coding guide produced by the Bureau of the Census contains no geographic coordinates for block faces or block centers. The Bureau is attempting to produce and distribute such a geographic base file. This geocoded ACG file contains (in addition to the information listed in the ACG), the X and Y coordinates of street intersections (nodes). It is called the DIME file (Dual Independent Map Encoding). When such a file is available for a district, it may be used in place of the ACG. Since this file is not currently available for many Standard Metropolitan Statistical Areas, the methods being

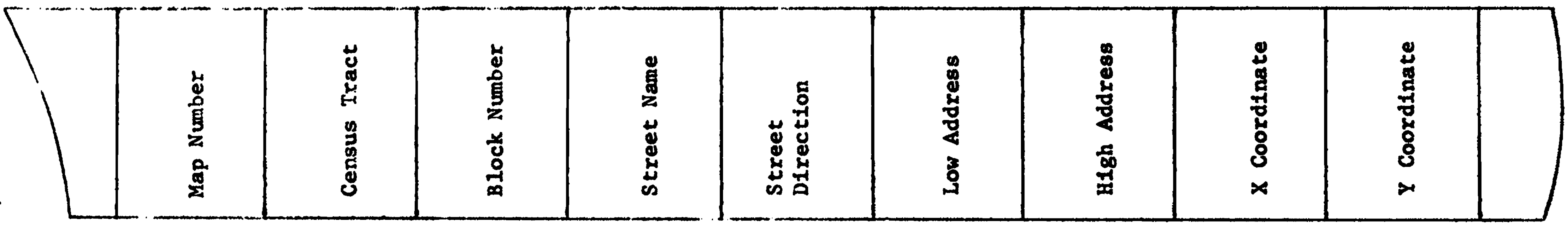
discussed continue to have applicability. Figure 6 illustrates a record in the ACG containing the information extracted from the Census ACG plus the X and Y coordinates of the block center.

Records in both the census produced ACG and the locally generated set of digitized block centers are labeled by block number within census tract, within map number. Both of these files of information are sorted in the same order and each block face on the ACG is related to the geographic coordinates of the associated block center. This merger is illustrated in Table 1, for the block diagram given in Figure 4. The final step in the process of building an address coding guide is to sort the geocoded ACG, produced above, on low street address, within direction, within street name. Sorted in this order, it will be most useful in merging with the student data to be discussed next.

The ACG produced in this manner enjoys a utility beyond applications specific to the schools. The ACG when merged with an address related data file will produce a geographic data base. Files similar to the student data file exist in many local agencies, such as the police department, welfare department, and local planning office. Such variables as incidents of traffic accidents, traffic flow, welfare cases and population density become available for display. The reason that this is mentioned here is that production of a geocoded ACG is moderately expensive, and since it would be of utility to other local agencies, they might be willing to share the cost of its development.

Building the Student Data File

The data file created must contain all of the information about the units under study to be used for sorting, counting or for mapping. The information specified in the data record might include background and educational variables, such as: birthdate, sex, AFDC status, ethnicity, grade, school, and test score data. The exact information included will, of course, vary from location to location and application to application.



ADDRESS CODING GUIDE RECORD

FIGURE 6

CENSUS ACG

Map No.	Census Tract	Block Number	Street Name	Direction	Low Address	High Address
4	8	29	ADAMS ST.	N	601	699
4	8	29	ELM ST.	N	601	699
4	8	29	6TH ST.	E	800	898
-	-	-	-	-	-	-
4	8	47	OAK ST.	N	501	599
4	8	47	6TH ST.	E	801	899
4	8	47	ELM ST.	N	500	598
4	8	47	5TH ST.	E	800	898

DIGITIZE BLOCK CENTERS

Map No.	Census Tract	Block Number	X Coord.	Y Coord.
4	8	29	6	9
-	-	-	-	-
4	8	47	5	5

MERGED ACG

Map No.	Census Tract	Block Number	Street Name	Direction	Low Address	High Address	X Coordinate	Y Coordinate
4	8	29	ADAMS ST.	N	601	699	6	9
4	8	29	ELM ST.	N	601	699	6	9
4	8	29	6TH ST.	E	800	898	6	9
4	8	47	OAK ST.	N	501	599	5	5
4	8	47	6TH ST.	E	801	899	5	5
4	8	47	ELM ST.	N	500	598	5	5
4	8	47	5TH ST.	N	800	898	5	5

MERGING THE CENSUS ACG AND THE DIGITIZED BLOCK CENTERS
TABLE 1

Our purpose is not to discuss that information to include in the file, but rather to present a strategy by which any file might be used to form a geographic data base. That is not to suggest that consideration of the contents of this file is not critical, since it ultimately sets the limit of application for the geographic data base. Figure 7 is a flowchart displaying the process of building a student data file.

In addition to the information specified above, the student's address must be included on the student data record, since it forms the basis of the merge of the student data file and the address coding guide. The student address, including street name, direction and number are required. The syntax should be the same as on the ACG. An example of this student data record is shown in Figure 8. The complete SDF is then sorted in the same order as the address coding guide: house number within street direction within street name.

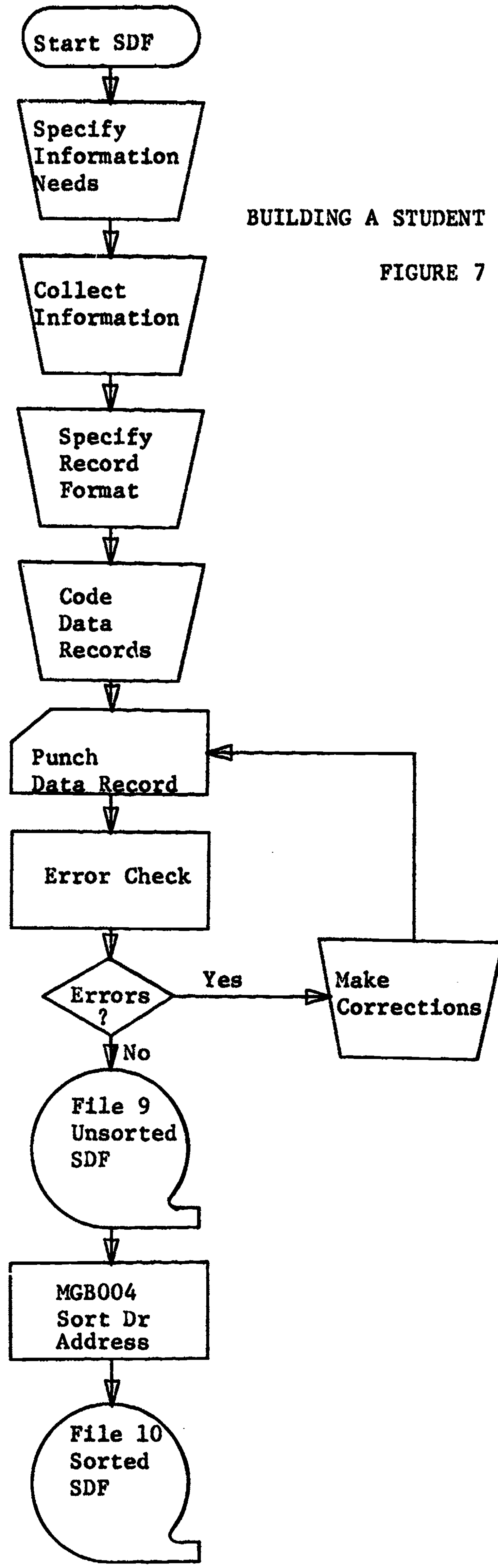
Creating the Geographic Data Base

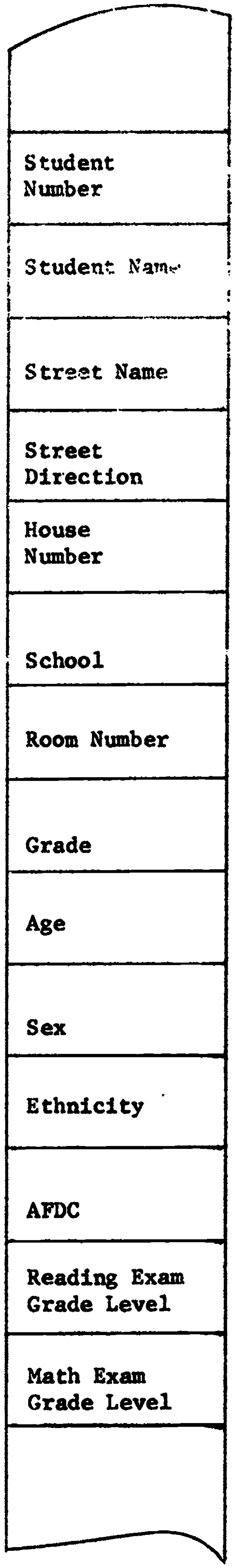
The process considered in this section entails merging the two files just created: the address coding guide and the student data file. While the merging process itself is a relatively straight forward operation, it is at this point that the incompatibilities between the two files become apparent and need to be corrected. The majority of the processing in this phase of building the geographic data base is centered on resolving the inconsistencies between the ACG and SDF. Figure 9 is a network of this process.

Since the SDF and the ACG are sorted in the same order, the merging takes place by comparing the address on each student record with the address ranges for the same street name and direction. In general, there are two block faces associated with each street and address range, these being the two sides of the street;the two block faces are, however, assigned to different block centers. Figure 10 shows a portion of the SDF and the ACG

BUILDING A STUDENT DATA FILE

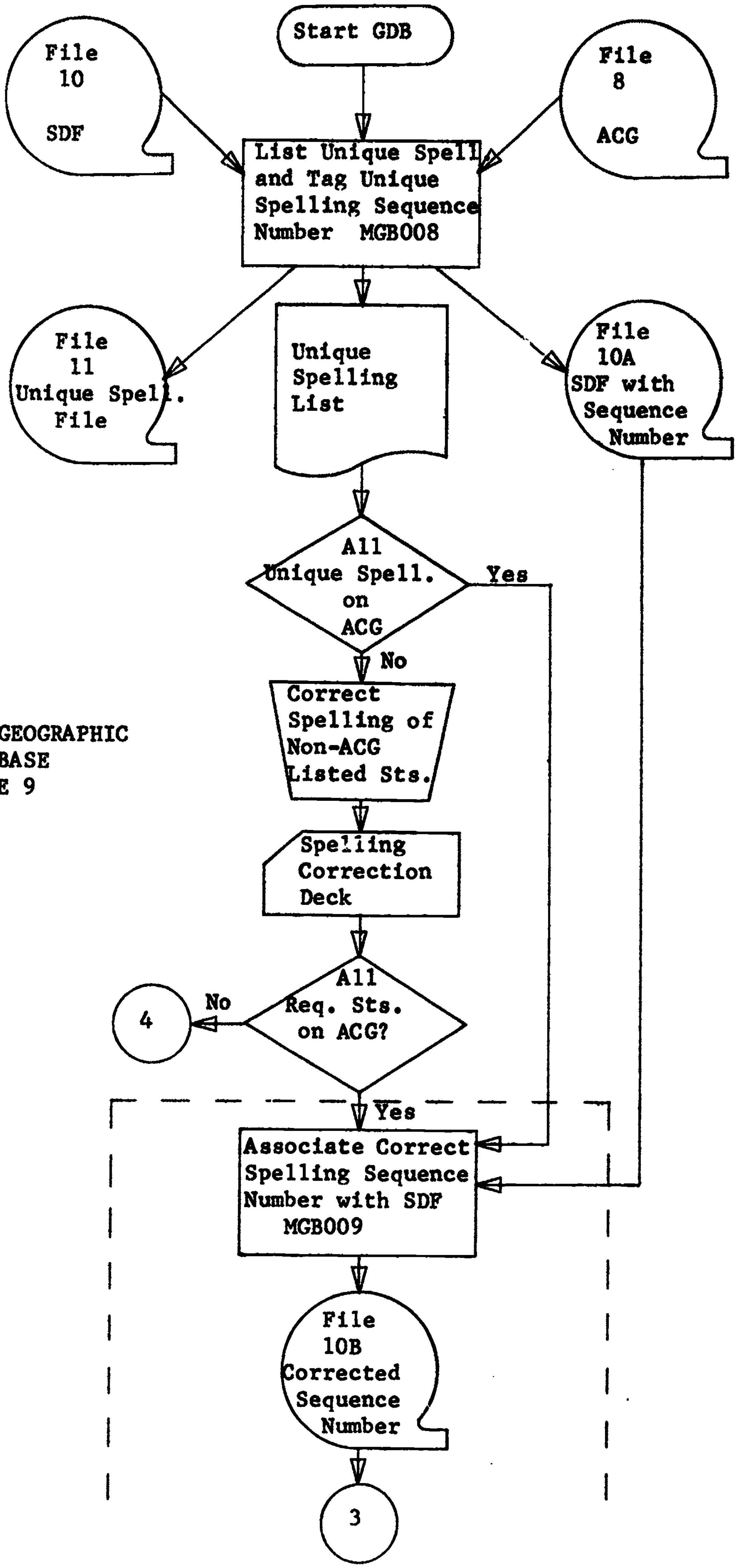
FIGURE 7



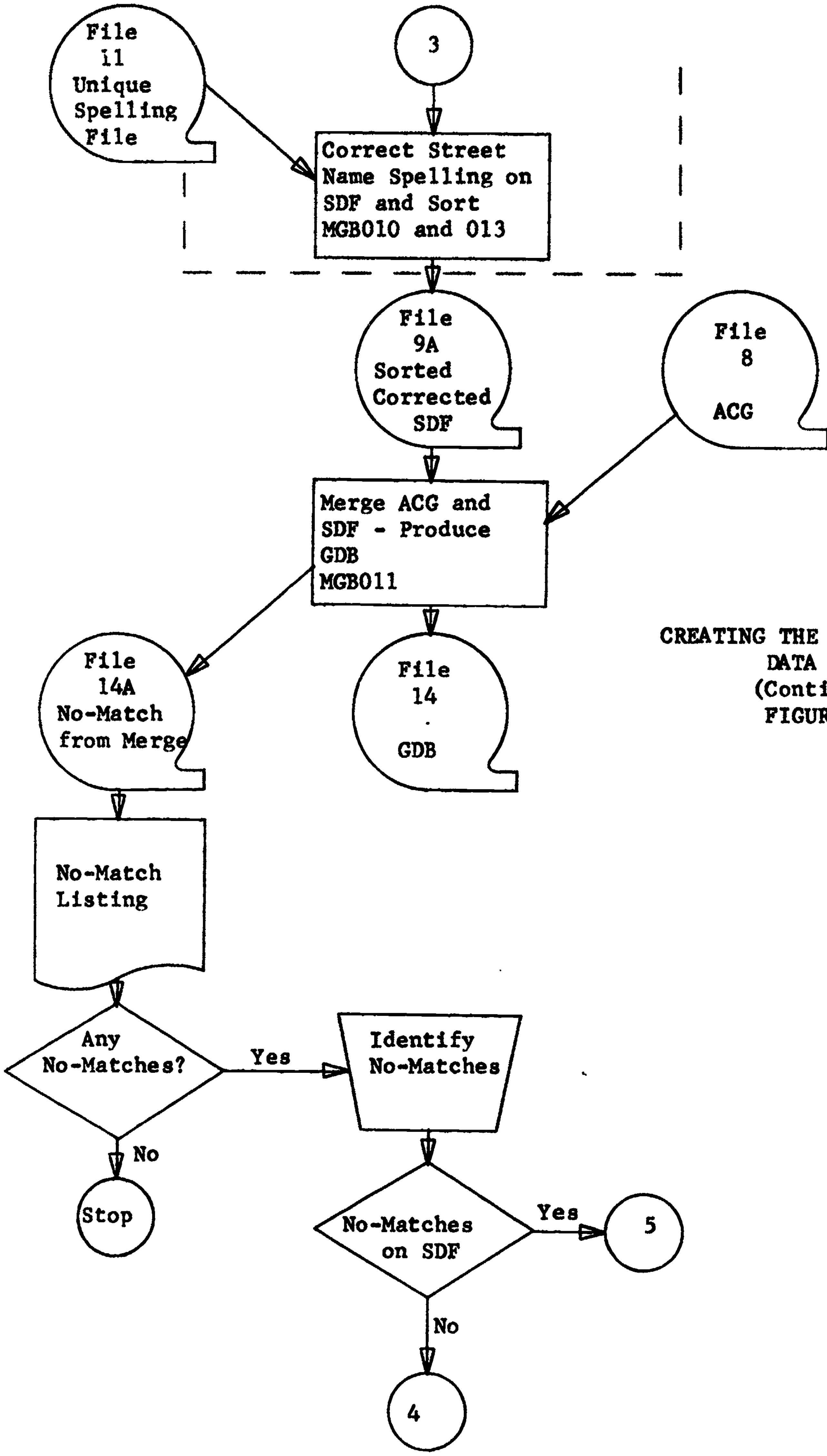


STUDENT DATA RECORD

FIGURE 8



CREATING THE GEOGRAPHIC
DATA BASE
FIGURE 9



CREATING THE GEOGRAPHIC
DATA BASE
(Continued)
FIGURE 9

STUDENT DATA FILE

Student Number	Street Name	Direction	Number
168127	ADAMS ST.	N	323
230467	ADAMS ST.	N	346
253923	ADAMS ST.	N	348
209968	ADAMS ST.	N	401
103215	ADAMS ST.	N	406
175252	ADAMS ST.	N	457
268786	ADAMS ST.	N	484

ADDRESS CODING GUIDE

Street Name	Direction	Low Address	High Address	X Coord.	Y Coord.
ADAMS ST.	N	301	399	396	417
ADAMS ST.	N	300	398	382	417
ADAMS ST.	N	401	499	396	453
ADAMS ST.	N	400	498	382	453

MERGING THE STUDENT DATA
FILE AND THE ADDRESS*
CODING GUIDE

FIGURE 10

with an arrow indicating the association of the individual student record with the appropriate block centers. The two possible block faces for each address are distinguished on the basis of odd or even address.

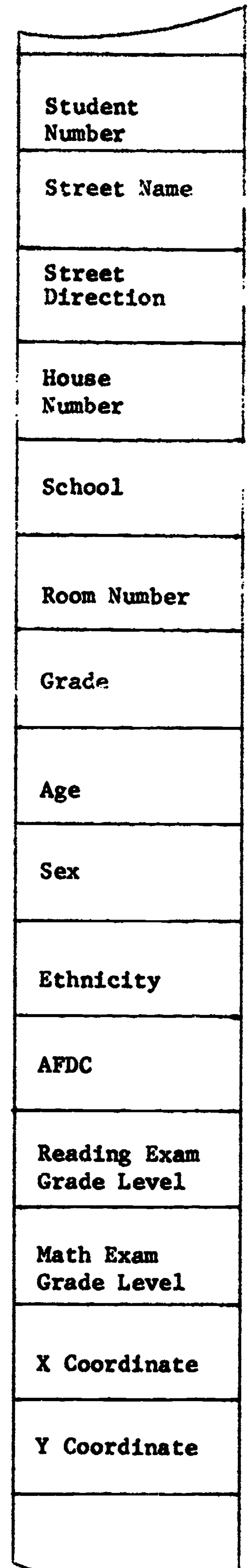
On the initial run, it is unlikely that a satisfactory merge will be achieved due to errors and inconsistencies in the files. The most common error encountered at this point in processing may be traced to spelling and abbreviation differences between the street names listed in the two files. Inconsistencies due to streets and addresses on student records not included in the ACG call for updating the ACG. Incomplete or incorrect information on the student record will necessitate updating the student record file. The updating procedures for these two files will be discussed later in this paper.

Running the program to merge the SDF and the ACG produces two additional files: the unique spelling file and the sequenced student data file. The unique spelling file contains an ordered listing of each distinct street name spelling in the two merged files. Those spellings from the ACG are marked with an asterisk and each unique spelling is labeled by a sequential integer. The sequenced student data file associates with each student record in the SDF the sequence number of the address spelling in the unique spelling file. A tape listing of the unique spellings is also produced at this time. For each entry in this unique spelling file, it must be determined whether the ACG should include this unique spelling or whether the spelling in the SDF is incorrect and needs to be converted to a spelling already listed in the ACG. (The ACG update process will be discussed later). The procedure for correcting misspelling consists of matching the current sequence number to the correct sequence number. While some of the inconsistencies between the two files may be resolved through

automated means, the great bulk of differences must be resolved by manual means. This is the case, since a program which can associate HILL DALE with HILLDALE is also likely to associate FIR ST with FIRST ST. Once an error of this sort finds its way into the geographic data base, it will be very difficult to correct. All incompatibilities identified at this point must be carefully checked to determine the correct spelling.

A corrected and sequenced student file is produced from the card deck of file changes and the old sequenced student data file. If the sequence number of a student record appears in the change deck, it is converted to the corrected sequence number as indicated in the match file. The corrected file is then sorted in order to the corrected address sequence number. Those street names which were incorrectly listed on the SDF may now be corrected by changing the street name on the SDF to the one associated with the corrected sequence number on the unique spelling file. At this point, all street names represented in the SDF should be listed in the ACG and when sorted on low address, within direction, within street name, this file is a corrected equivalent of the SDF developed in the preceding section.

The ACG and the corrected SDF may now be merged, with X and Y coordinates being added to each record in the resulting student file; this is the geographic data base (GDB). Also produced at this juncture is a listing of no-matches which occur when information on the SDF is incomplete or in error, or if the ACG is not complete. Errors in the ACG may result from student addresses outside the limits specified on the ACG, or when incorrect street directions are indexed in the ACG. No-matches at this point in the processing imply the necessity of updating either the ACG, the SDF, or both. A sample record from the GDB is shown in Figure 11.



GEOGRAPHIC DATA BASE RECORD

FIGURE 11

Updating the Address Coding Guide

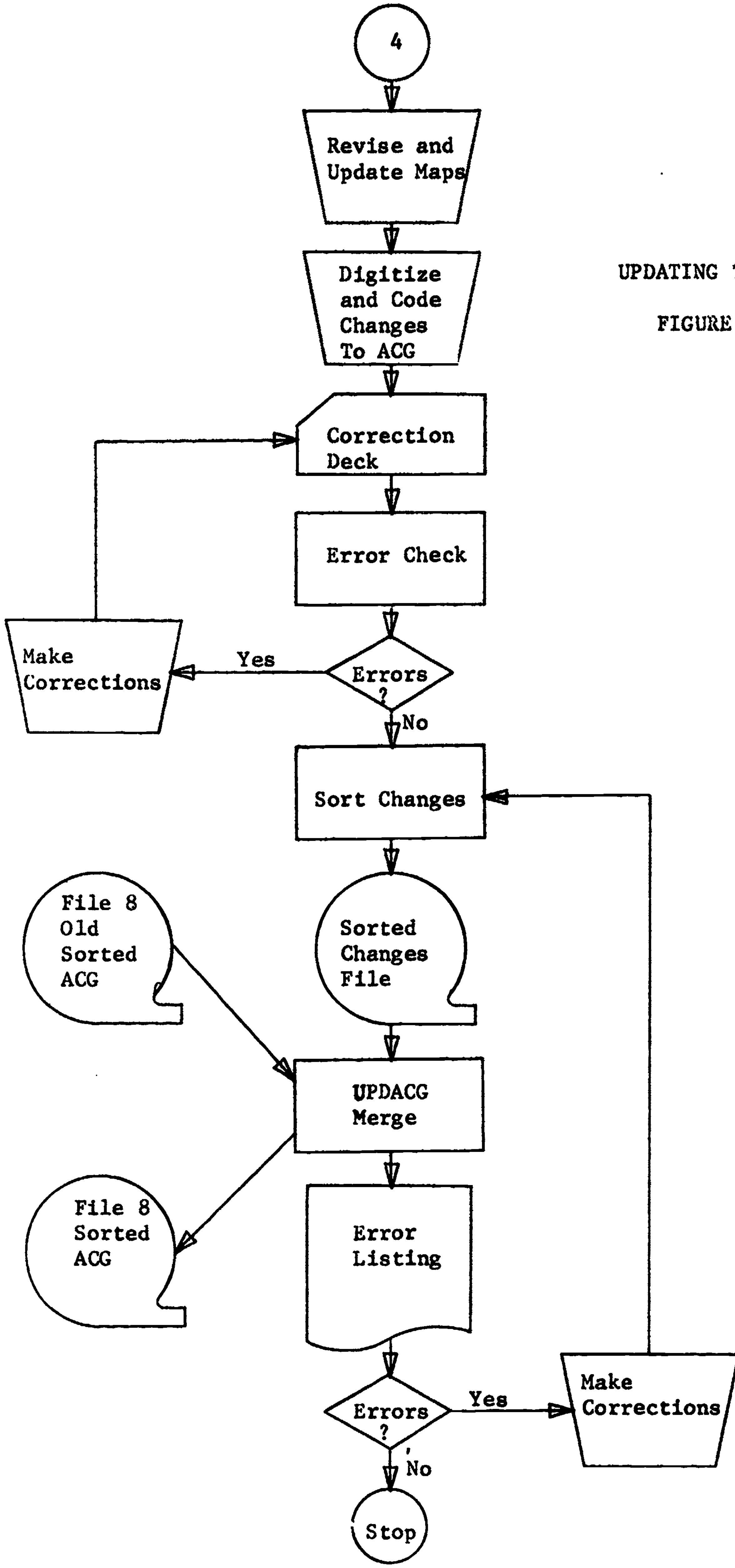
Those parts of a city which are rapidly changing are frequently the areas of most interest to school decision makers. These are the areas, usually on the fringes of the district, which are experiencing new subdivisions and the new block faces and are in most need of updating.

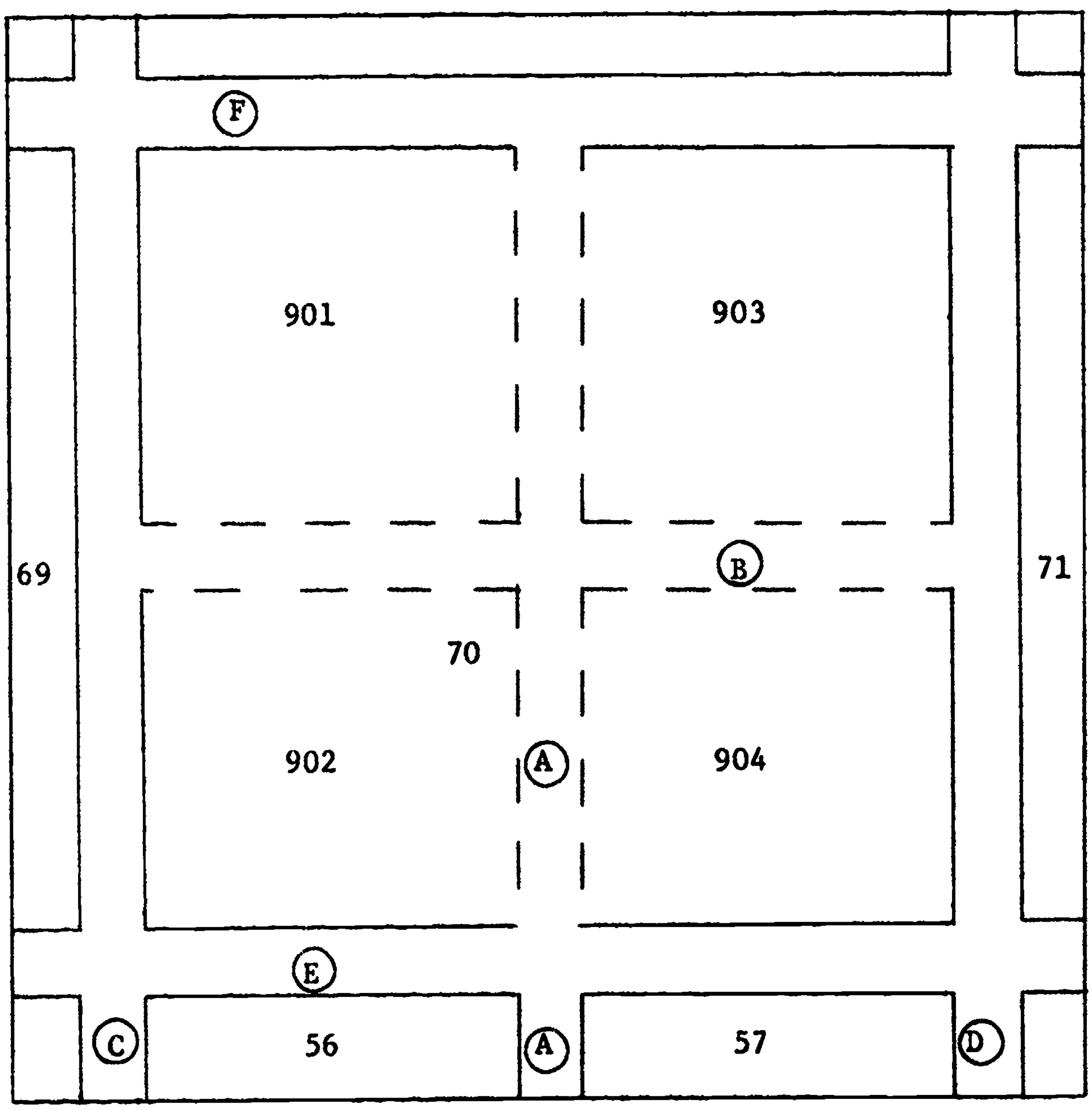
It is crucial for school district applications that systematic procedures be established for periodic updating of the ACG. Figure 12 outlines such a procedure. Errors requiring updating of the ACG may be identified at two points in the process of building the geographic data base: 1) when correct street names in the student data file are not found in the ACG and 2) when no-matches occuring in the merge between the corrected SDF and the ACG are attributable to the ACT. The most comprehensive review can be associated with the latter. Careful review of unique spellings and no-matches is essential if an accurate ACG is to be maintained, as the SDF provides a useful check on the completeness of the ACG.

When updating the ACG, it is important to correct the tape file and the maps. To the extent possible, numbering of blocks should be consistent with those used by local city planners. This temporary numbering of blocks within census tract will be subject to periodic updating of numbering by the Bureau of the Census. The first step in the updating process, then, is to identify and verify the changes to be made, to determine what block faces are to be added, changed or deleted. An example of an updating problem is given in Figure 13. Street A has been extended through the center of block 70 and a new street, B, has been completed through the center of block 70, perpendicular to street A. Four new block centers have been created, numbered 901, 902, 903 and 904; block center number 70 has been deleted. Block faces on streets C, D, E and F which were associated with block center number 70, need to be split at the appropriate address

UPDATING THE ACG

FIGURE 12





UPDATING THE ACG

FIGURE 13

limits and linked with the related block centers. The eight block faces generated by the new streets also need to be associated with their respective block centers. All of these changes must be noted as block face additions and deletions in the ACG and coded into computer readable form. The X and Y coordinates of the new block centers must be computed and added to each of the block face records of the ACG.

The correction deck for updating the ACG is then sorted in the same order as the ACG, that is, low address within street direction, within street name. In this order, the correction deck is used to update the old ACG, producing a new sorted ACG for introduction into the GDB process.

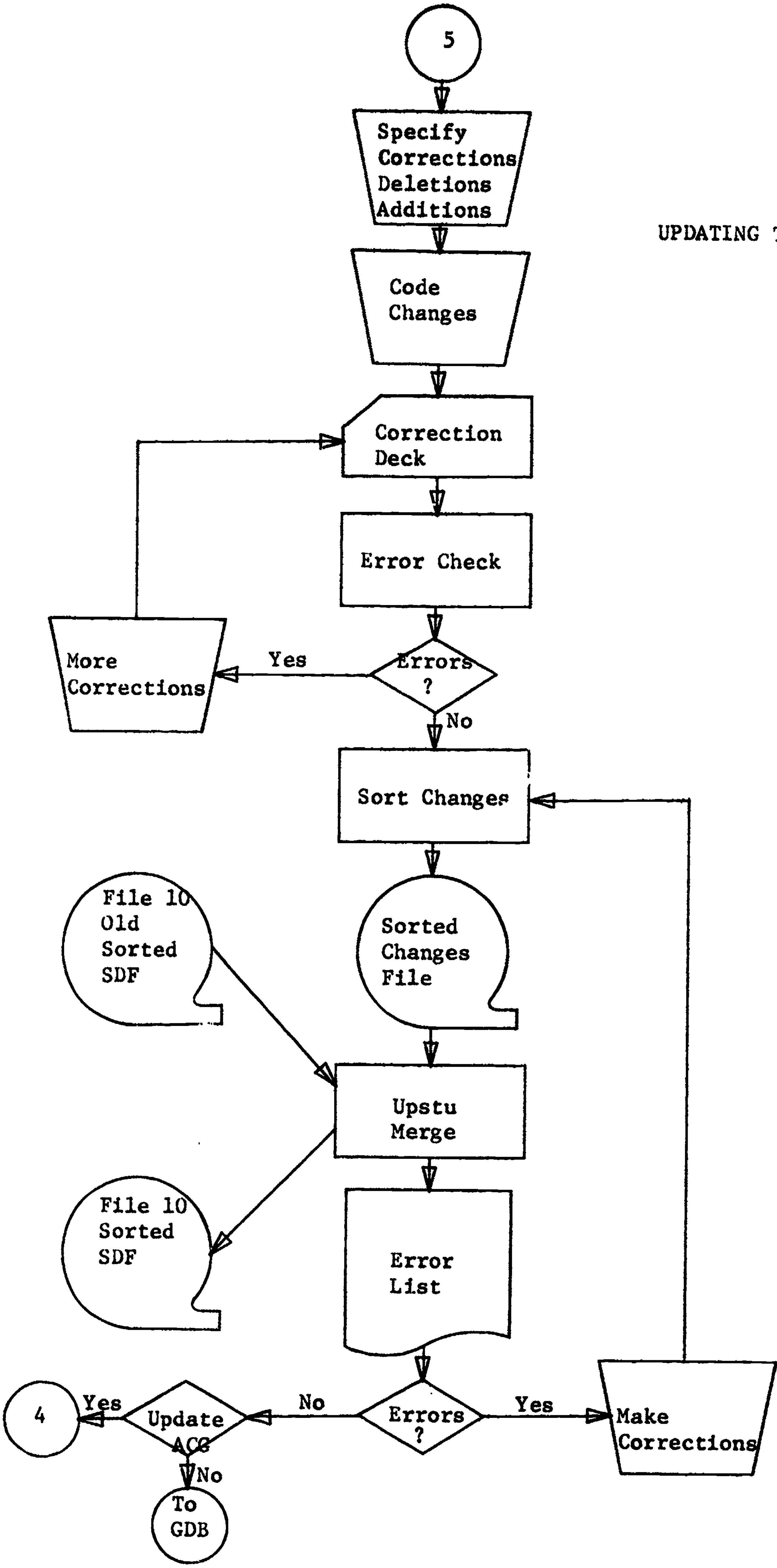
Updating the Student Record File

Similar to the ACG, it is critical that systematic procedures be established for updating the student data file. The update of the student file involves: 1) the addition of new students entering the district schools, 2) the deletion of students leaving the district schools, 3) the periodic review of information on all students remaining in the schools (annual or semi-annual), 4) the correction of errors identified in merging ACG and SDF. Only the last of the activities listed will be identified through the geocoding process. These errors result from incorrect information coded in the SDF which make it impossible to associate the student data record with a block face in the ACT. The process of updating the ACG is shown in Figure 14.

For the periodic review of information on students remaining in the district, it is usually best to generate a listing of information currently on file for each student. This information may be distributed to the school and room number coded in the student record for review and correction by the teacher or student.

UPDATING THE STUDENT DATA FILE

FIGURE 14



The procedures for updating the SDF begin with identifying the corrections, additions and deletions to be made. These revisions are coded in machine readable form and sorted on address, within street direction, within street name, the same order as the old SDF. The old SDF is then revised to include the corrections in the change deck, producing a new SDF for input into the Geographic Data Base program.

Summary

The process described in the preceding is one approach to building a geographic data base using students as a point of reference.

The procedure capitalized on currently available information, in particular the Address Coding Guide and Metropolitan Maps produced by the United States Bureau of the Census, and student data usually on file at the district level. Since the availability of the Address Coding Guide is limited to Standard Metropolitan Statistical Areas (SMSA), somewhat revised procedures from those described here would need to be used in smaller cities and districts. The importance of systematic and periodic procedures for updating the address coding guide and the student data file was also emphasized in order to ensure the ongoing accessability of accurate and timely information displayable on a geographic base. While Geographic Base Files (DIME) may soon be available from the Bureau of the Census for some districts, they are not currently readily available for most districts and were therefore not used as a basis for this discussion, their availability would greatly enhance creation of the student geographic data base.

TOPIC III

THE APPLICATION OF TREND SURFACE ANALYSIS

Donald N. McIsaac

Geographers, geologists and meteorologists have developed and employed tools for the display of areal distributions of data. The depiction of meteorological or topographic data in the form of a contour map reflects the visual display of large amounts of information. Moreover, these displays may be rapidly produced by digital computers coupled with high speed plotters. The graph or map depicts information in a highly parsimonious fashion, permitting the researcher to get a feel for data not usually attainable through tables.[1] There are many analytical methods for the production and display of map data. This paper reviews the development of a most promising

technique for map analysis, trend surface analysis.[2]

The basic objective of trend surface analysis is to identify a low frequency signal across a broad geographic surface and separate it from local random noise effects.[3] A variety of techniques have been employed for the analysis of surface trends. A most promising approach appears to be the analysis by the least square fitting of a polynominal surface.[4] The output from such a model may be coded (presented in contour form), illustrating the trend or broad regional effect. The method is analytical in that an analysis of residual may be produced. This residual indicates the quality of the depiction. If mapped, the analysis may reveal hidden trends. An expression of the sum of squares explained by the regression provides an assessment as to the quality of the overall map. The simplist polynominal is the linear surface:

$$Z = C_1U_1 + C_2UV + C_3V$$

Where:

U = displacement in X direction
V = displacement in Y direction
Z = statio: or location value

Illustrative Map
Average 8th Grade IQ Scores

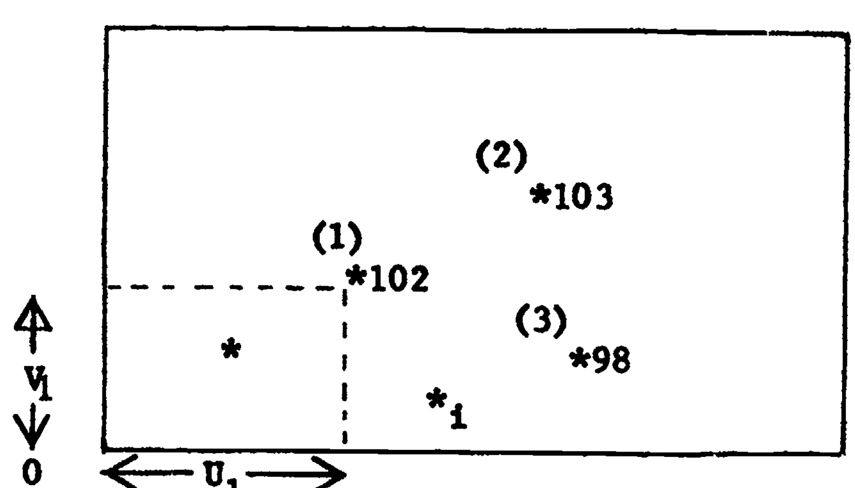


FIGURE 3.1

In the example cited above, school i is located U_i inches west of 0 and V_i inches north of 0 and the 8th graders have a measured IQ of 102. The data matrix for such a set might be as follows:

School ID	U	V	IQ
1	U_1	V_1	102
2	U_2	V_2	103
3	U_3	V_3	98
i	U_i	V_i	--

Where I = 1,N

The depiction and analysis can be expanded by employing a higher order equation. McIntyre contributed significantly to the field with his program for the computation of trend surfaces 1-8.[5] His work provided routines for automatic scaling of high order computations to minimize the possible loss of significant figures. The capability of computation of higher order equations provides a depiction of a convoluted or curved surface. Once the coefficients for the surface have been computed, a grid is produced from the trend surface model. Just as the regression equation serves as the descriptive model of linear relationship, the trend surface equation serves as the descriptive model of the surface. The depiction illustrates the low frequency trends which are too broad in effect as to admit to random local occurrances. The trend surface does not demonstrate the precise value of every point on the surface in the same way that a linear regression does not pass through every point of the scattergram. The coefficient of determination, however, does provide some insight as to the quality of the map. (SS explained.)

Several applications have been made of the trend surface model for providing an areal view of geographically displaced data. Trend surface offers the advantage of estimating grid data from randomly spaced points. Many of the natural centers of population do not conform to the nice neat grids useful in the production of contour maps. Using trend surface analysis, it is possible to compare or contrast attributes associated with different data bases.

Vote data associated with level of income or incidence of poverty is often a difficult and time-consuming comparison. The basis for identification of income figures is often associated with zip code areas or census tracts. On the other hand, voter response is always associated with precincts. Rarely, if ever, do the precincts coincide with census tracts. A trend surface computed from the set of points representing precincts can be compared to the trend surface computed on family income or incidence of poverty.

The map on the following page, Figure 3.2, illustrates the effect of a multi-million dollar bond election in recent years in a large mid-western city. (It should be noted that not all maps in this document have been produced from a common data base. The identity of the cities remains anonymous by the careful mixing of data.) Figure 3.3 illustrates the incidence of poverty clearly indicating the high correspondence between poverty and support for education. Note the saddle in the northwest section of the city, indicating a low area of bond election support. The population in that part of the city is less dense and it reflects the fringe of a transitional area. Support for the bond in the extreme northwest is high. The area is growing and is in need of new facilities.

While such a depiction is really no surprise regarding the voting patterns of the large city, it does serve to reinforce some biases regarding attitudes toward school and/or taxes. The map illustrates that support for schools is coming from the inner core. It is a relatively new trend.

Similar maps produced over time could reveal what the trend has been and could verify the occurrance of a significant change in voting pattern. If such analysis is linked to major social and/or political events of the time, it may be possible to identify the antecedents or causes of the

PERCENT OF VOTE IN FAVOR OF BOND ELECTION
TREND SURFACE 3RD DEGREE

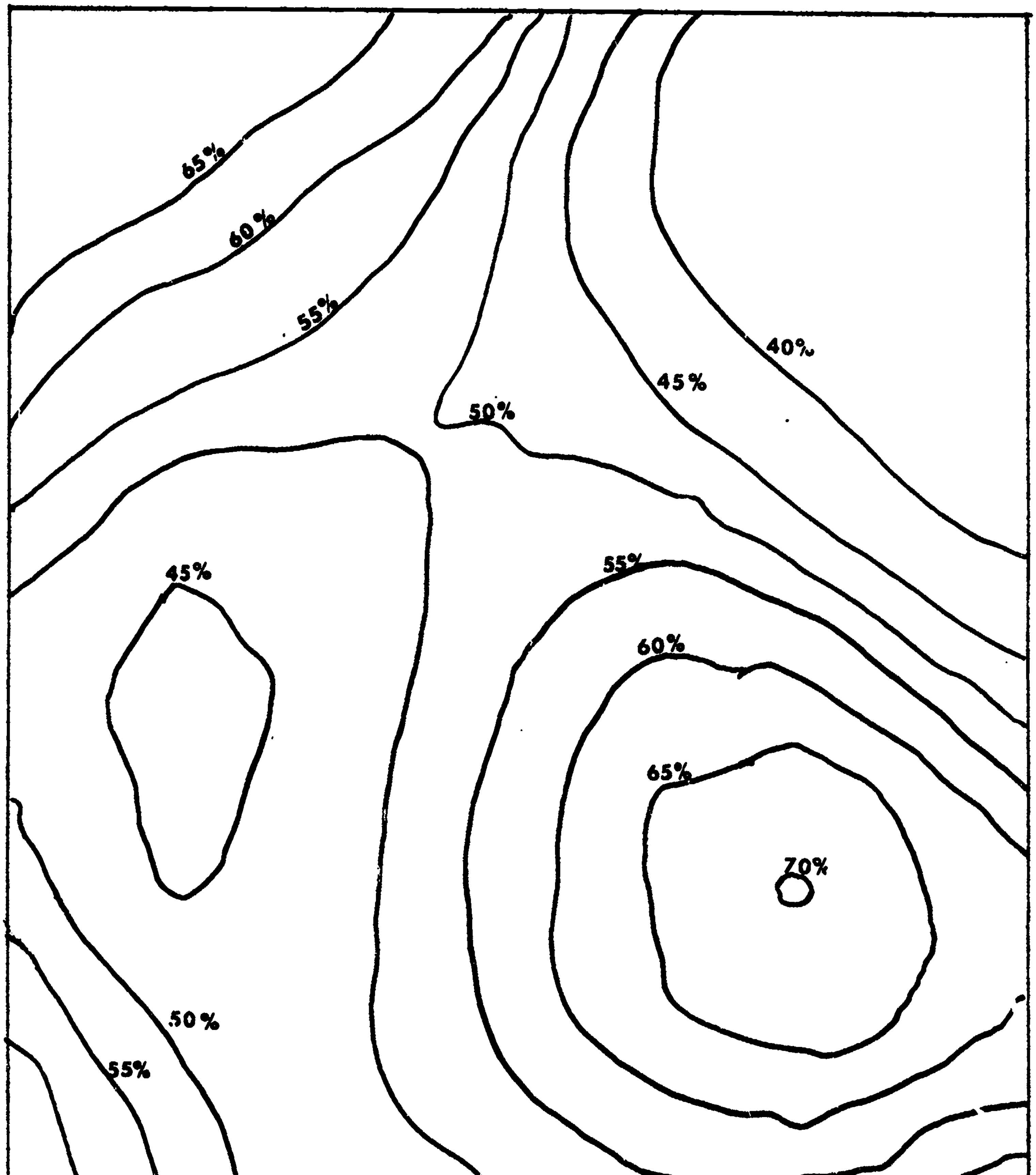


FIGURE 3.2

INCIDENCE OF POVERTY
Number of AFDC Cases

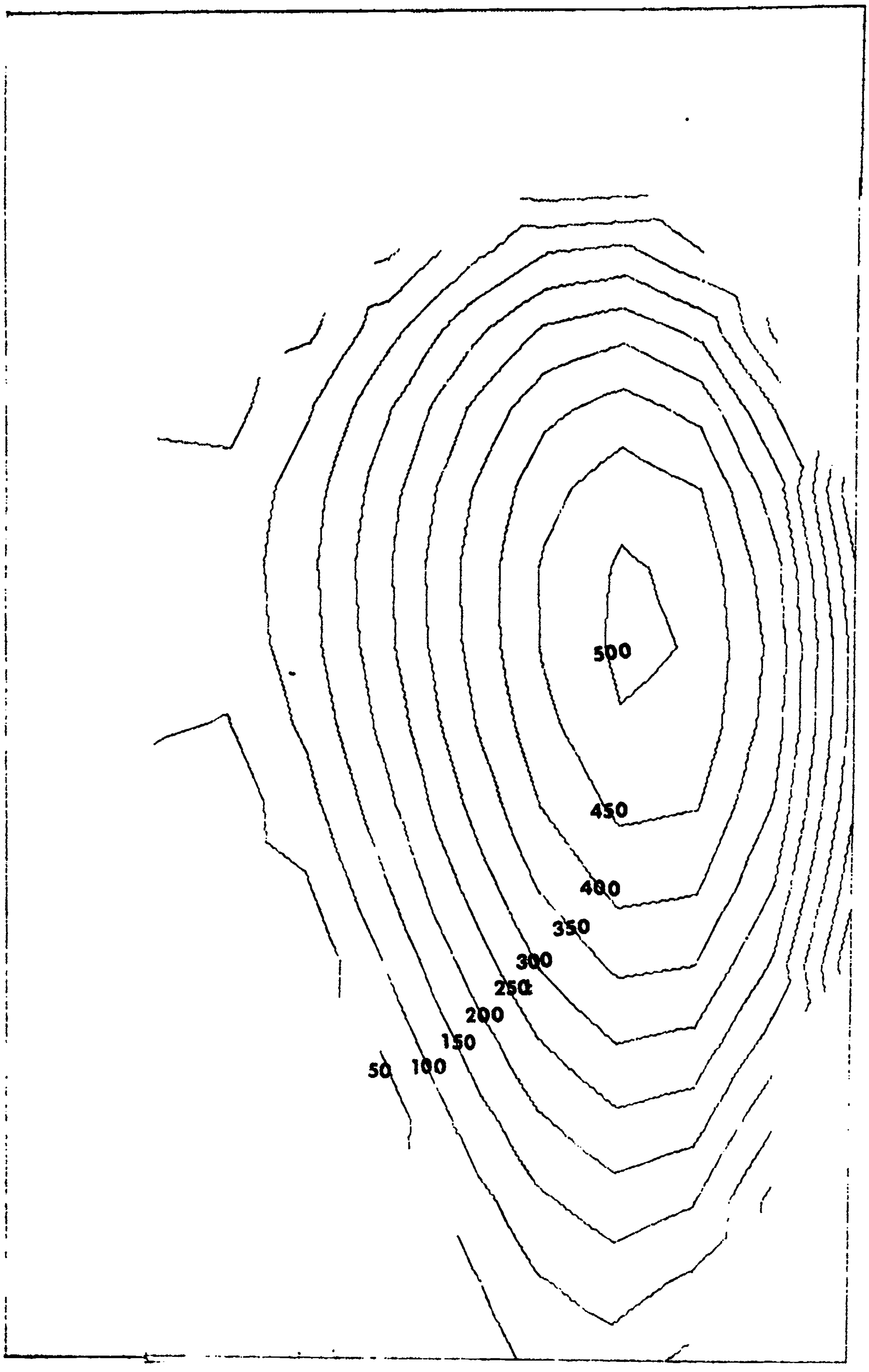


FIGURE 3.3

hypothesized change. One theory dealing with the nature of this change might draw upon a basic philosophy of both the economic opportunity act and the elementary secondary education act. Both of these hold the notion of self-rule as central. Both advocate the formation of community action committees which are to take active part in the administration of program. Does the change in voting pattern tend to follow the formation of these important community committees? On the other hand, one might hypothesize the change in pattern as a function of increased taxes. Careful analysis of taxes paid vs voting pattern change could help support the thesis.

The Analysis of Achievement

Achievement data when agregated over relatively large geographic areas offer some interesting possibilities for trend surface analysis. Let's assume that each school represents a data station. The coordinates or location of each must be carefully measured. These values together with the achievement score are coded into cards. The trend surface program will generate a surface which reflects the best least-squares fit wherein the station value (average reading score for 3rd grade) is expressed as some function of the station location. In regression problems, the U-V coordinates serve as the independent variables and the Z value as the dependent variable. It is the same problem as a multiple curvalinear regression where the location is assumed to be related to the station value.

The map, Figure 3.4, illustrates the trend of achievement for the second grade in fall, 1970. It is evident that the central city suffers some in the average level of achievement. Moving in all directions from the center, but specifically to the north, the average 2nd grade reading ability tends to increase. The early 2nd grade Trend Surface map serves as

READING - GE - Grade 2 1970

Trend Surface 4th Degree.

72% SS Explained

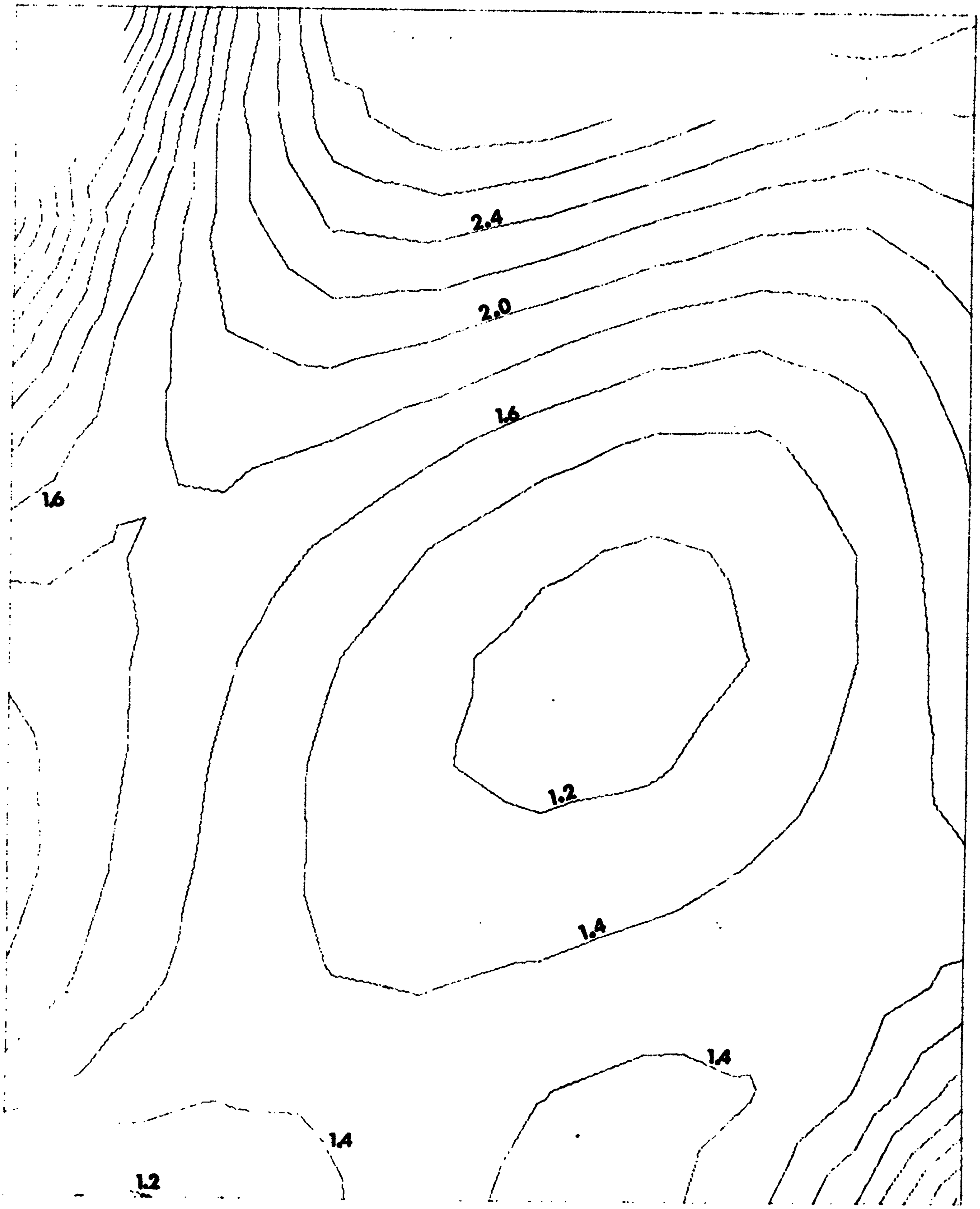


FIGURE 3.4

a basis for assessing the educational program. Additional achievement tests were administered in grades 2 through 6 during the second semester. The test scores were aggregated within schools and grades. Much of the variance was washed out, but then we were interested in the broad low frequency surface trends. In the 2nd grade, 71% of the total sum of squares was explained which is equivalent to a multiple R of .85. Such a high coefficient indicates the map is an accurate depiction of the surface trends and reflects a tight fit of the school values to the surface. Figure 3.6 illustrates the summary of all tests, the high coefficients indicate the quality of the fit and the efficiency of the trend surface model.

After the base map was produced, a map depicting the 2nd grade students' achievement at the end of the year was produced. This map, Figure 3.5, illustrates that at least one year's grade equivalent in achievement had occurred in the six months between test periods. The schools in the core area had improved a significant amount, but not nearly so well as the schools in the north. The steeper gradient in Figure 3.6 is indicated by the increased number of contour lines.

Reading in Grade 4 was treated in a similar manner. Again, the steeper gradient indicates that the students beyond the transitional areas both started at a higher level of achievement and maintained a higher level of growth during their 4th grade year. The overall trend pattern is similar to that of the second grade revealing no remarkable or significant changes. The students to the north are again characterized as high achieving. Two inches of the area on the left side of the map is outside the city and school district limits. The data points in the area are sparse to the point of counter productive. The results on the left side of each map can be considered spurious as they reside outside the control points.

READING - GE - Grade 2 1971

Trend Surface 4th Degree

61% SS Explained

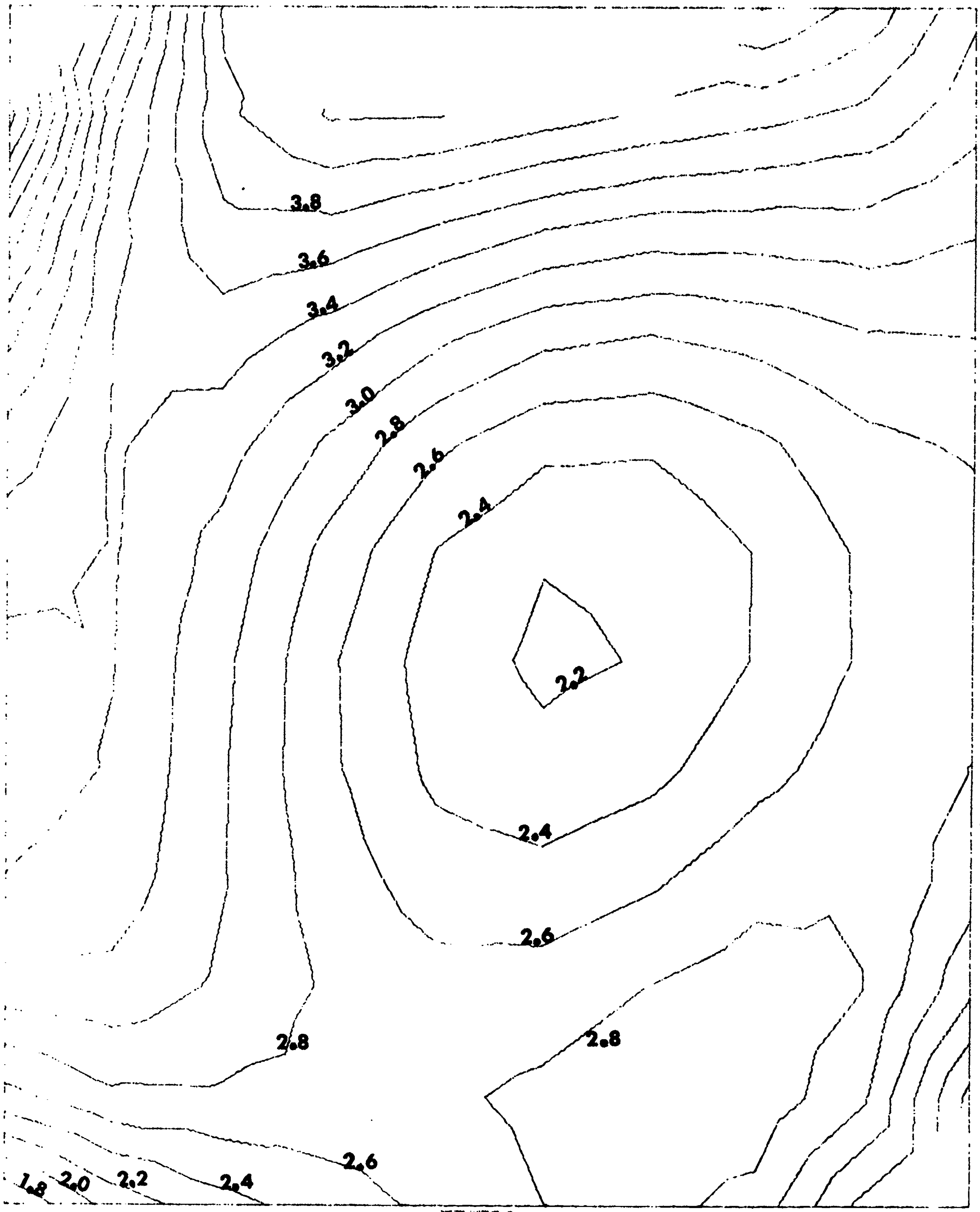


FIGURE 3.5

ARITHMETIC - GE - Grade 4 1970
Trend Surface 4th Degree
64% SS Explained

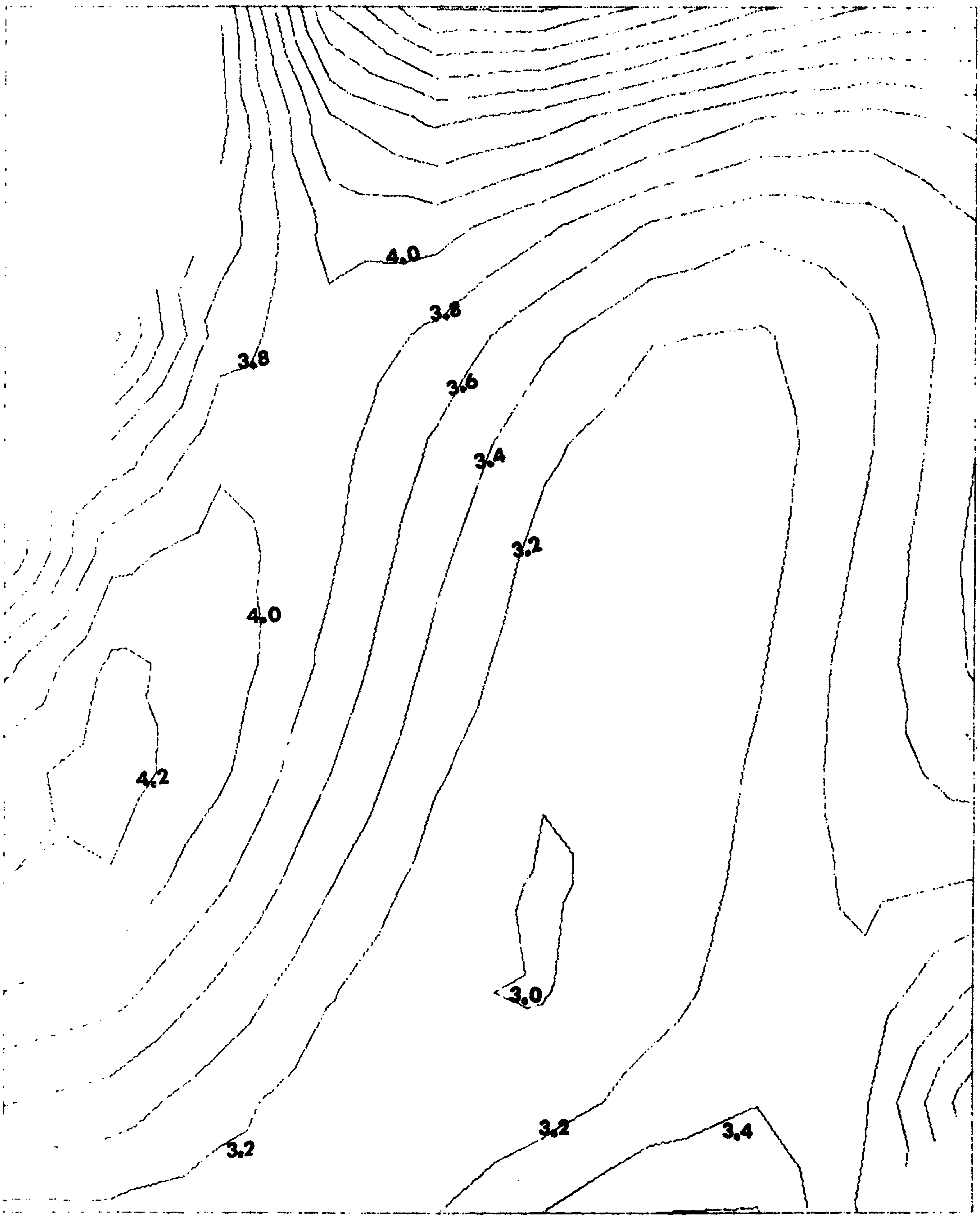


FIGURE 3.6

One refreshing aspect of the pre-post maps is the progress made in the urban core area. A reading improvement of 1.2 grades in 6 months is good. A similar set of maps drawn on a similar set of variables in 1967 indicated that the progress was actually negative and that the average achievement dropped .2 grade level in the core schools each year. Even though the increased achievement is noticable in the core area, it is even more remarkable in the higher achieving areas. The saddle in the northwest corner has improved from 4.2 in the fall to 6.0 in the spring for an improvement of 1.8 grade equivalent in 6 months.

Analysis of Residuals

In addition to the general depiction and indication of trend, the trend surface techniques offers the opportunity to review the local effects as well. Table 3.2 illustrates a partial list of the schools and their residual values for 6th grade fall semester. Each line represents a school labeled by an identifier. U and V reflect the distance (in inches) each school is displaced from the origin. (Note that the output maps were produced at 40% of scale.) Y is the actual average value for each school and PRED is the value estimated from the regression surface. The residual is the actual less the predicted. School N.48 produced at a level 1.5 grade equivalents above expected. The cause of such a deviation is not evident from this output. Further study is required to determine if the high is a random effect or in fact the result of an excellent program. One might wish to look carefully at schools 48, 160, 177, 182 and 190. Each achieved a positive residual score of at least one grade equivalent. Careful analysis of the residual may reveal that significant information is imbedded in the residual as noise. It is possible to plot the residuals and determine if any geographic pattern exists.

MAP STATISTICS

1970-71		Reading		Arithmetic		
Grade	Semester	Portion SS Explained	Multiple R	Portion SS Explained	Multiple R	N
2	1	.72	.85	.74	.86	122
3	1	.80	.89	.66	.81	123
4	1	.73	.85	.64	.80	123
5	1	.79	.89	.76	.87	125
6	1	.79	.89	.75	.87	123
2	2	.61	.78	.51	.71	122
3	2	.69	.83	.63	.79	122
4	2	.67	.82	.63	.79	122
5	2	.74	.86	.68	.82	125
6	2	.73	.85	.65	.81	122

TABLE 3.1

ANALYSIS OF RESIDUALS

3 DEGREE RESIDUAL

ID	U	V	Y	PRED	RES
19	11.05	12.54	6.30	5.96	.34
31	12.89	7.80	6.20	6.01	.19
44	13.48	11.54	6.70	6.06	.64
48	17.94	3.79	8.10	6.60	1.50
55	13.83	6.82	5.80	6.20	-.40
57	13.32	12.57	5.30	6.11	-.81
63	11.48	6.60	5.80	5.91	-.11
67	11.56	6.46	6.70	5.93	.77
69	9.78	15.22	7.60	6.65	.95
71	14.23	7.78	5.40	6.21	-.81
72	14.71	13.81	5.50	6.39	-.89
80	13.90	10.63	6.00	6.09	-.09
82	13.12	10.39	5.00	5.99	-.99
84	13.13	13.25	5.60	6.16	-.56
92	9.36	16.16	7.40	7.09	.31
96	12.98	5.77	5.70	6.15	-.45
97	9.97	13.04	6.20	6.07	.13
98	13.42	5.59	6.00	6.21	-.21
103	17.94	11.43	6.90	6.69	.21
111	7.61	2.25	6.60	6.14	.46
112	14.75	14.04	6.60	6.42	.18
116	14.46	10.39	5.30	6.17	-.87
118	20.18	18.75	7.60	7.89	-.29
122	12.92	3.38	6.40	6.29	.11
124	13.99	7.27	5.90	6.20	-.30
131	16.06	15.06	6.80	6.72	.08
134	13.17	10.27	6.20	5.99	.21
136	15.13	8.03	6.10	6.33	-.23
147	14.41	11.75	6.10	6.19	-.09
149	11.39	3.46	5.80	6.13	-.33
152	19.65	3.65	6.30	6.46	-.16
154	13.02	14.59	5.50	6.35	-.85
155	13.42	6.08	6.60	6.18	.42
156	11.59	11.46	6.70	5.88	.82
158	10.98	.73	6.10	6.27	-.17
160	11.66	17.88	8.60	7.43	1.17
163	16.61	16.98	6.80	7.16	-.36
165	13.43	12.22	5.60	6.09	-.49
166	13.50	2.18	7.00	6.39	.61
167	16.41	8.94	5.80	6.49	-.69
170	20.35	2.13	6.30	6.07	.23
175	15.63	14.19	6.60	6.55	.05
177	19.25	10.48	8.00	6.79	1.21
178	14.41	6.97	6.40	6.27	.13
182	18.43	2.60	7.50	6.4[illegible]	1.02
183	14.37	12.30	5.90	6.21	-.31
184	13.99	15.91	6.20	6.69	-.49
186	15.39	14.80	7.00	6.60	.40
187	11.95	20.80	9.20	9.06	.14
189	13.81	10.58	6.30	6.08	.22
190	11.40	16.14	8.10	6.76	1.34
191	17.78	17.93	7.10	7.51	-.41
192	17.50	16.66	6.80	7.18	-.38

TABLE 3.2

The Dissemination of Information

In assessing the educational needs for Title III in Wisconsin, the success of the dissemination function was investigated using trend surface analysis. Six hundred fifty-five people were identified in a sample of 40 school districts. The educators were asked to respond to an instrument indicating their familiarity with the 43 current Title III projects.[6]

One of two theories are useful for conceptualizing the dissemination problem. The agriculture experiment station concept or the pebble theory may be the best way to spread the knowledge of these fine programs. The purpose of the agricultural experiment station is to put the experiment in a highly visible, close proximity to the public. The theory being that information will travel in concentric circles from the exemplary program. The purpose of the model for dissemination was to deliver exemplary programs around the State. Each would affect the immediate surrounding area and thus dispense information concerning exemplary educational programs.

Each of the Title III projects has a unique purpose dedicated to some aspect of education. T ee of the forty-three projects were selected for the analysis. They were:

1. Cooperative curriculum center
   Plymouth, Wisconsin
2. Pilot Mobile Diagnostic Reading Lab
   Appleton, Wisconsin
3. Mobile Exemplary Instructional Materials
   Center, Madison, Wisconsin

Interviewers questioned each of the 655 respondents regarding their familiarity with each of the projects. The scale was as follows:

No Knowledge	Read a little about	Have read a lot about	Have implemented the program

While the scale is crude, it does address the concept of familiarity. If the pebble theory is correct, one would expect three separate maps each based upon the responses to a specific project to reveal the concentric circler which emminate from each pebble dropped in the water. The effect would be that familiarity would be an inverse function of distance from the project epicenter.

An alternate to the pebble theory might be called the well-tuned antenna theory. In this model, one could hypothesize that around the State are a limited number of school districts which maintain a constant vigil on the current projects of the day. These districts pride themselves in knowledge of state and national trends and respond with clear objective analysis to each. They may not implement everything they see, but they sure are aware of the possibilities. Such a district would have personnel knowledgeable about the state Title III programs.

If the "well-tuned antenna" theory is true, one would expect maps depicting familiarity to be centered around these super-sensitive centers. In fact, one would expect to see the same pattern emerge on each of three project depictions and the apex of each peak would approximate the location of the "well-tuned antenna." The three maps illustrate the findings. (Figures 3.7, 3.8 and 3.9.) The average familiarity tends to be quite low as was demonstrated by the relatively flat surface and the fact that the surface lies exclusively between, "never heard anything about the project," and "I've read a little about it." Each map shows a peak (small hill) located approximately on the center of the project. Apparently, school people are aware of projects located nearby. There is some evidence that an appropriate model for the dissemination of project information rests with the agricultural experimental station model.

READING - GE - Grade 4 1971

Trend Surface 4th Degree

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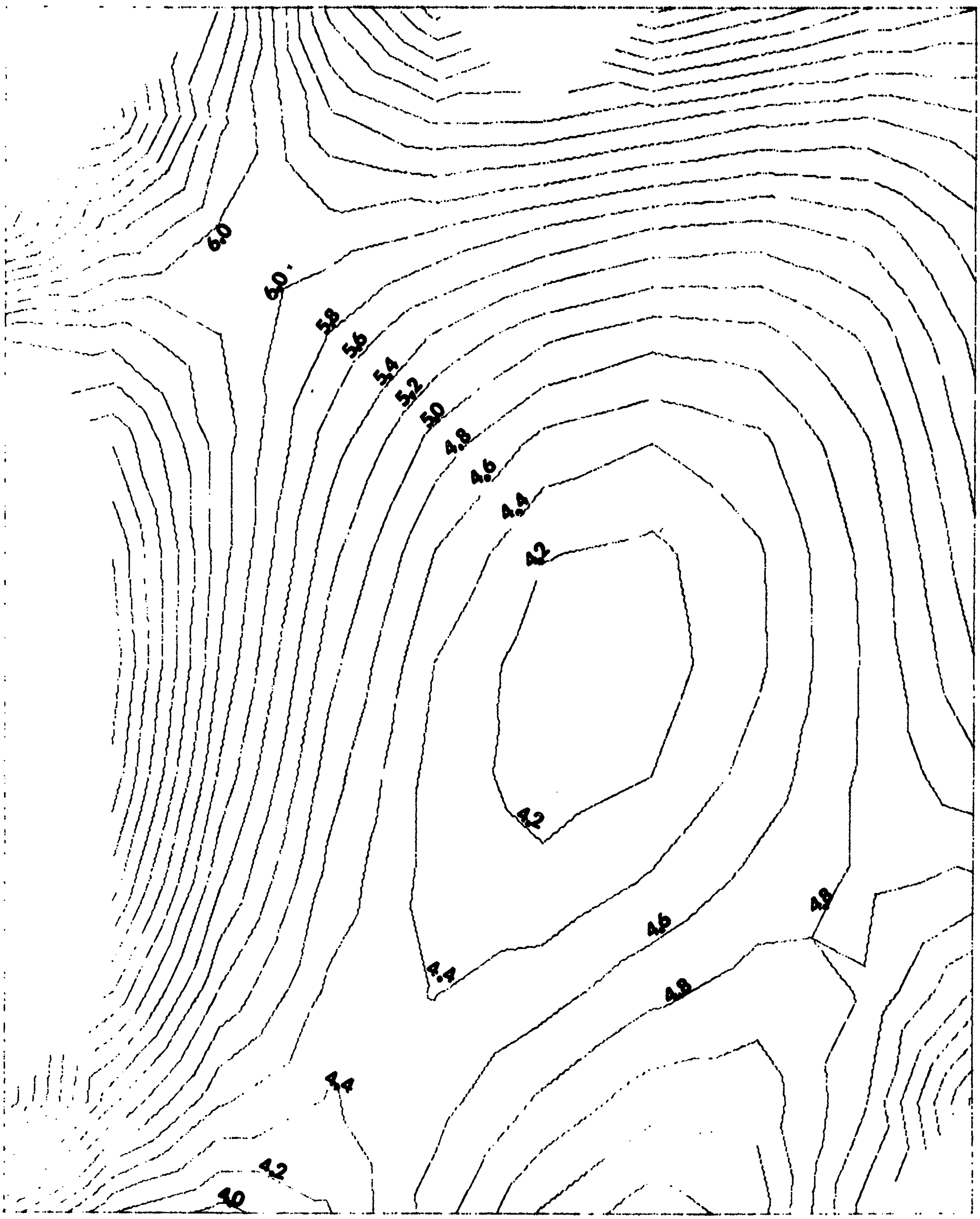

FIGURE 3.7

COOPERATIVE CURRICULUM DEVELOPMENT CENTER
Plymouth, Wisconsin

Level of Familiarity

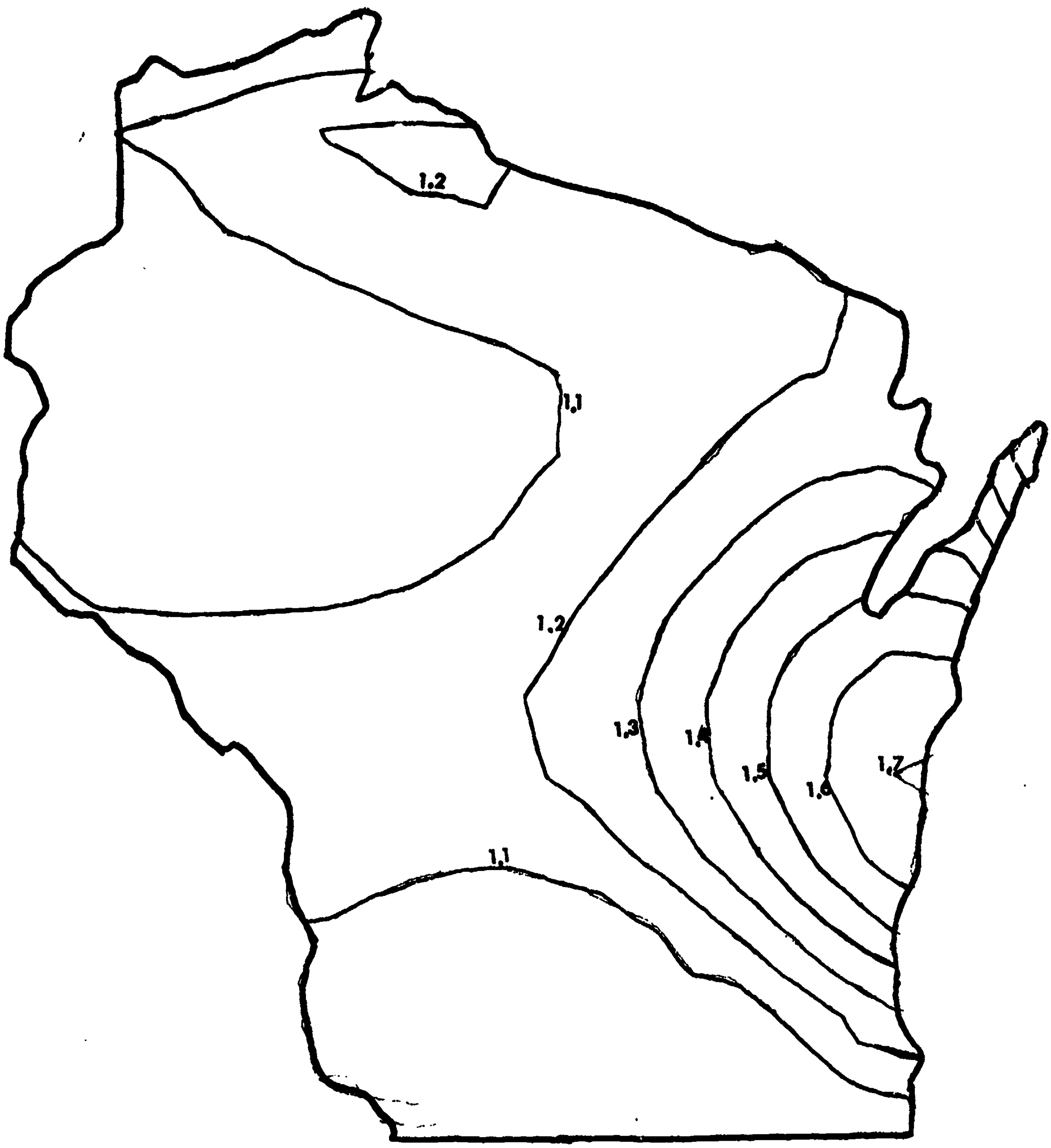

FIGURE 3.8

PILOT MOBILE READING LABORATORY
Appleton, Wisconsin

Level of Familiarity

FIGURE 3.9

MOBILE DEMONSTRATION -
INSTRUCTIONAL MATERIALS CENTER
Madison, Wisconsin

<u>Level of Familiarity</u>

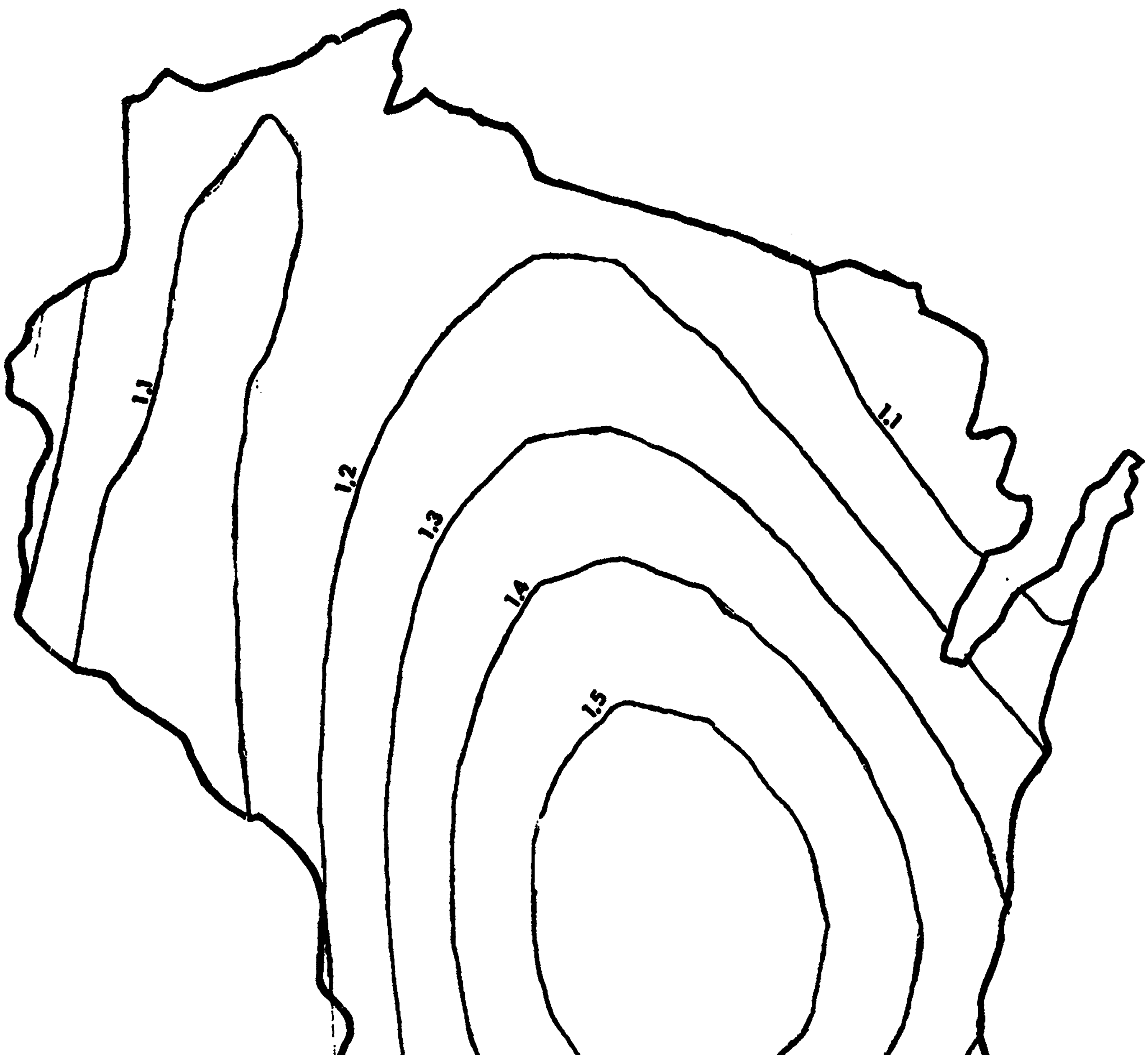

FIGURE 3.10

Summary

Trend surface analysis is a method for reviewing and analyzing areal data. The models of trend surface may be employed to depict a situation which exists and provide a reasonable display of randomly spaced data. Since the process can be completely computerized, large volumes of data can be processed in a short period of time. The results of computer procedures are abitrary but consistent and are not sensitive to the subjective aspects of producing similar information by hand. When treated twice, a given data set will produce exactly the same result. Speed of computation and reproduceability of results are two compelling reasons for the use of trend surface analysis.

The technique can be used to model the results of a given grid or to smooth the effect of random occurrance. Trend surface models offer much to the researcher in the estimation of data basis. The trend surface equation permits sampling from a pre-specified surface and estimating the parameters of a given area. For example, an estimate of the population of a given area could be accomplished very inexpensively when a trend model of population density represents the data base instead of a large and massive data base. One high order polynominal can be integrated with greater speed and less cost than passing a file of 800,000 or more records. Thus, trend surface, at one swipe, offers highly readable and parsimonous depictions of data, analytical assessment regarding the quality of the model, and powerful estimating capability so necessary to administration and research through simulation.

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[6]Lipham, Gregg, McIsaac, Morrow, Wisconsin Needs Assessment 1968, Wisconsin Department of Public Instruction.